# Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING
FIVE DOLLARS A YEAR

AUGUST 1954

*Glass Laminates*
*Germanium Rectifiers*
*Fluid Couplings*
*Zirconium Properties*
*Why Parts Fail*
*Hydrogen Brazing*

GUNFIRE COMPUTER

This 25-ton induction stirrer is fastened to the bottom of a 90-ton capacity electric arc furnace.
One of the coils for the stirrer, made of Revere rectangular copper tube. Coil is 12 feet long, over 6 feet wide.
Revere Copper
helps stir molten steel

When steel is produced in an electric arc furnace it is highly desirable to stir the molten metal, to assure uniform heat and avoid stratification of the various alloy constituents. Manual and mechanical methods have been used, but the most modern method is electrical—induction stirring. This is accomplished by sending low-frequency two-phase currents through copper coils immediately under the furnace. The magnetic field thus produced stirs the melt most effectively. Stirring can be reversed, and the contents of the furnace made to flow toward either the slag door or the pouring lip.

Because of the heavy currents required, copper's high electrical conductivity makes it essential. Since the stirring coils are close to the furnace, they must be water cooled, distilled water being used in a closed system. Copper's high thermal conductivity is vital here. The basic copper for the stirrers made by Elliott Company, Ridgway, Pa. for Aros Electric, Inc., New York, is Revere rectangular tube, .945" x .750", .157" wall. Elliott and Revere technical personnel worked closely on the problem of specifications, arriving at joint agreements on tolerances and temper suitable for bending. These proved successful from the start, again showing the value of close collaboration between Revere and its customers . . . If you have a problem in connection with copper and its alloys, and aluminum alloys, consult Revere. See the nearest Sales Office.

**REVERE**
**COPPER AND BRASS INCORPORATED**
*Founded by Paul Revere in 1801*
230 Park Avenue, New York 17, New York

*Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Michigan; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.*
*Sales Offices in Principal Cities; Distributors Everywhere.*

SEE "MEET THE PRESS" ON NBC TELEVISION, SUNDAYS

# Product Engineering

AUGUST, 1954

Volume 25 Number 8

Why Parts Fail ..... J. A. Bennett and G. W. Quick 129

Single-Curvature Technique Speeds Body Profiling .... G. M. Kelley 135

Induction Potentiometers ..... Sidney Davis 138

Product Designs ..... 144

Dry Hydrogen Brazing ..... Floyd C. Kelley 156

Polyester-Glass Laminates ..... Eugene McLaud and Frank Gustafson 161

How Quality Control Can Affect Casting Costs ..... Roland N. Laveen 169

Non-Rubbing Seals for Oil Retention ..... David C. Spaulding, Jr. 172

Fluid Clutches for Electric Drives ..... James A. Morrison 174

Resonance Amplitudes ..... H. Norman Abramson 179

Strength of Zirconium ..... J. H. Keeler 183

Germanium for High Power Rectification ..... C. E. Hamann 188

Calculating the Area of Curved Surfaces ..... Victor Tatarinov 201

Highlights ..... 5
Design Perspectives .. 123
Editorial ..... 127
Technical News .... 193
New Parts and Materials 208
New Catalogs and Bulletins ..... 274
Meetings ..... 292
Sans, Sauci ..... 294
Engineering Abstracts . 296
News Books ..... 310
Readers Letters ..... 320

**Product Engineering**

AUGUST, 1954 VOL. 25, NO. 8

*THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING*

*Member of Associated Business Publications and Audit Bureau of Circulations*

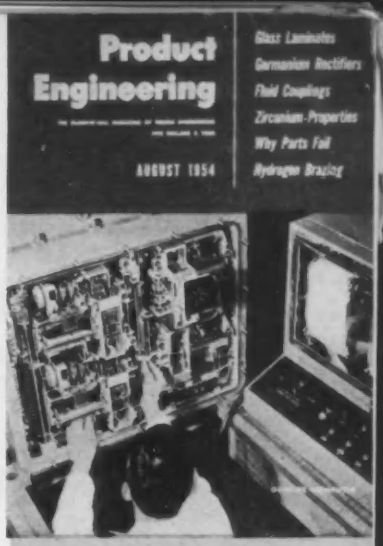
Published monthly by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), founder. Publication office, 99-129 North Broadway, Albany 1, N. Y. Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42nd St., New York 36, N. Y. Donald C. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Executive Vice-President, Publications Division: Ralph B. Smith, Vice-President, Editorial Director; Nelson Bond, Vice-President, Director of Advertising; J. E. Blackburn, Jr., Vice-President, Circulation Director.

Subscriptions: Product Engineering—Subscription Service, 99-129 N. Broadway, Albany 1, N. Y., or 330 W. 42nd St., New York 36, N. Y. Allow one month for change of address.

Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. Position and company connection must be indicated on subscription orders.

Single copies 50c. United States and possessions, $5 for one year, $8 for two years, $10 for three years; Canada, $6 for one year, $10 for two years, $12 for three years; other Western Hemisphere and the Philippines, $15 for one year, $25 for two years, $30 for three years; all other countries, $25 for one year, $40 for two years, $50 for three years. Entered as second class matter Aug. 21, 1936, Albany, N. Y. Post Office, under act of Mar. 3, 1879. Printed in U. S. A. Copyright 1954 by McGraw-Hill Publishing Co., Inc. —All rights reserved.

*Number of copies printed this issue 31,575.*




### THIS MONTH'S COVER

One of the U. S. Navy's complex gunfire computers receiving final test at the plant of Ford Instrument Company, Division of The Sperry Corporation. Designed and built for the Bureau of Ordnance this instrument computes continuous gun orders containing corrections for all the significant factors affecting anti-aircraft and surface fire. The corrections allow for the motion of ship and target during the time the projectile is in flight; for the curvature of the projectile path caused by gravity, drift and wind; for pitch and roll of the ship; and for many other factors.

### THE STAFF

Editor
GEORGE F. NORDENHOLT

Assistant to the Editor
JOSEPH KERR

Managing Editor
ROBERT W. CARSON

Associate Editors
EDWARD S. COBB
RANDOLPH P. DOMINIC
ELMER T. EBERSOL, Jr.
BYRON K. LEDGERWOOD
JAMES R. McDERMOTT

Assistant Editors
ROBERT E. ABBOTT
PAUL N. ANDERSON
ROBERT W. BRULEY
JOHN KOLB
NORMA J. VAN NESS
STEPHEN J. WILSON

Editorial Assistant
LILLIAN M. WITHAM

Consulting Editor
ROBERT E. BRUCKNER

Washington
GEORGE B. BRYANT, JR.

Publisher
ALBERT HAUPTLI

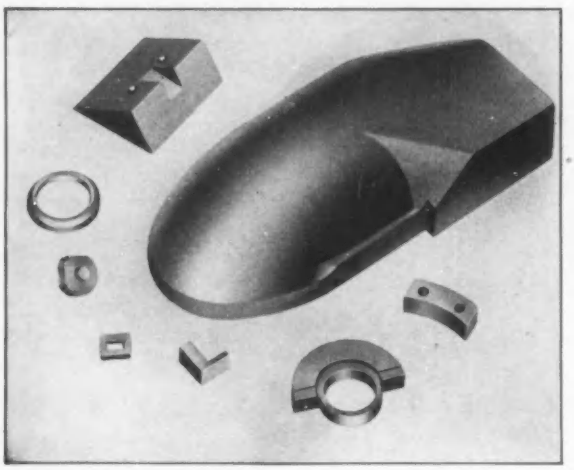
Advertising Sales Manager
STANLEY J. ALLING

Service Manager
HUGH BRITTON

Foreign News Bureaus:
LONDON • PARIS • BERLIN
SYDNEY • TOKYO
MEXICO CITY
FRANKFURT • SOA PAULO
BUENOS AIRES • MANILA

# Space Saver

# for a Guided Missile



**ONLY MALLORY 1000 METAL HAS THESE CHARACTERISTICS**

- A tungsten-base alloy weighing 16.96 grams per cubic centimeter.
- High tensile strength . . . 105,000 lb. per square inch.
- High modulus of elasticity. No objectional drift at rotational speeds as high as 40,000 rpm.
- Excellent machinability. Surface finishes from 10 to 40 microinches depending on method. Performance and chip form similar to gray iron.

***Mallory 1000 is also highly effective as a radiation shielding material.***

## Mallory 1000 High Density Metal *May be Your Answer, Too*

This tiny counterweight is a good example of how Mallory 1000 Metal can be used to make counterbalances and rotors smaller without sacrificing weight. The result is an improved, more compact product.

Mallory 1000 has a density of more than twice that of steel or brass, and it is easy to machine . . . characteristics that make it an ideal metal for use in balance weights and rotors whenever space is an important consideration.

When you use Mallory 1000 Metal you will also get the advantage of substantial savings in production. Mallory's exclusive contour pressing technique produces intricate shapes to close tolerances that require a minimum of finish machining.

Mallory 1000 can be your answer to an improved product; write for your copy of Technical Bulletin 6-7. It contains complete specifications and characteristics.

***Expect more . . .***
***Get more from*** MALLORY

**Serving Industry with These Products:**
**Electromechanical**—Resistors • Switches • Television Tuners • Vibrators
**Electrochemical**—Capacitors • Rectifiers • Mercury Batteries
**Metallurgical**—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

**For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio**

# Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear. These items represent current research and design developments soon to influence product engineering.

## METALLIC MATERIALS

....Titanium absorbs hydrogen at temperatures above 300 F, therefore, reducing atmosphere should be avoided in the heating of titanium alloys. Rem-Cru Titanium, Inc., Crucible Bldg., Pittsburgh, Pa. further reports that oxygen is absorbed above 1,300 F and nitrogen above 1,500 F. However, when titanium is heated in air nitrogen is not absorbed. Since titanium alloys can be hot worked with conventional steel mill equipment, small parts can be air heated prior to working. And salt baths can be used for quick heating to temperatures up to 1,600 F. Finishing temperatures should range between 1,350-1,550 F, depending upon the alloy and cooling in still air is recommended.

### HOLLOW TUBE-SHAPED PARTS. . . .

. . . .it is claimed, can be produced more economically from magnesium alloy by impact extrusion than by deep drawing, particularly if the drawing is a multiple stage operation. Magnesium Corporation of America, 5220 Indianapolis Ave., East Chicago, Indiana, has set up a separate division which reports that round, square or rectangular cross section hollow tube shapes can be impact extruded. Sharp radius between side walls and the bottom are claimed possible. Extrusion temperature range is 350-700 F, with only the die being heated. When the draw exceeds 45-50 percent, the impact extrusion is generally more economical.

### HIGH STRESSES AND TEMPERATURES. . . .

. . . .can be met by an alloy steel seamless tubing that is designed for use in jet engines, experimental aircraft and gas turbines. According to the Tubular Products Div., The Babcock and Wilcox Co., 161 E. 42nd St., New York, N. Y., the alloy has good strength characteristics at temperatures up to 1,200 F. Tests at 1,200 F indicate an oxidation resistance of 0.0008 in. penetration per yr. Impact strength at 80 F is 46 ft lb and at 1,200 F is 56 ft lb. Tubing is produced by a hot extrusion process for subsequent fabrication.

### BETTER, CHEAPER TITANIUM. . . .

. . . .is the claim being made for a new electric furnace that melts ingots of titanium in a vacuum. Titanium Metals Corporation of America, 60 East 42nd St., New York 17, N. Y., states that the quality of the titanium is improved. Reason given: more hydrogen is extracted from the ingot when it is melted in a vacuum than when melted in an artificial atmosphere of argon. Hydrogen is more detrimental to titanium's high-strength, heat-resistant qualities than previously thought. Vacuum technique also produces a smooth ingot requiring little or no conditioning before conversion into shapes.

### SULPHUR ADDED. . . .

. . . .to high speed steel and die steels have improved the machinability and self-lubricating qualities of the steels. According to the Latrobe Steel Co., 1944 Haller St., Latrobe, Pa., tool life is also increased 100 per cent and a better finish results. The additive does not affect the mechanical properties and the heat treatment specifications. Sulphur is added to the steel during the melting process, where it reacts with other alloying elements to form sulphides. Additive acts as a lubricant to reduce friction in the cutting process.

## NONMETALLIC MATERIALS

....Atomic radiation is being used to vulcanize rubber and increase the melting point of paraffin waxes. The nuclear reactor pile at Harwell, England is being used for these studies. Oxidation is not a factor in the vulcanization process. Energy alone, it is claimed, is responsible for the change in structure of the rubber —since the results are the same regardless of the type radiation used. Theoretical explanations of these changes in structure may lead to new applications of atomic energy in the production of plastics and other useful materials.

### A PLASTIC METAL . . . .

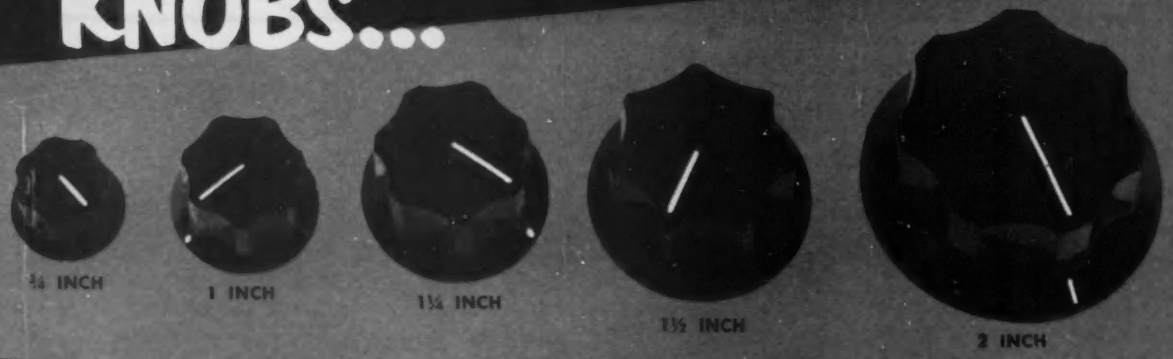
. . . . putty-like in form and that hardens without the use of heat or pressure into a strong metallic piece, is a development of the Chemical Development Corp., Endicott St., Danvers, Mass. Made of fine steel powders and plastic resin, the material can be used for drill jigs, fixtures, forming dies, plug gages, as well as caulking holes in metal castings. Material hardens in two hr without distortion or shrinkage.

### A METHOD OF TAGGING. . . .

. . . .gasoline molecules radioactively—with carbon 14—for studying petroleum process and gasoline use has been developed at the University of Chicago, Chicago,

(*continued on page 7*)

# KNOBS...

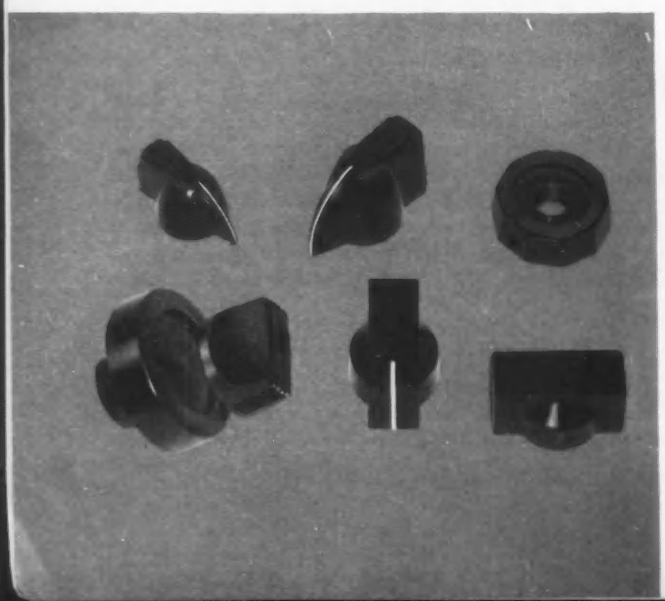



## A New All-purpose Functional Design In a Standard Line of Instrument Knobs

Now, without tooling charge of your own, you can dress up your instrument line with these beautifully designed, readily available knobs by Kurz-Kasch.

Look them over! Shown actual size, dimensions given are flange diameters. All sizes have ¼" shaft holes—come with or without brass inserts—any type of setscrew (one or more). Undersides are counterbored. Color, metalized, and filled or unfilled indicator lines at your option. Here's style at a price!

Turn to Kurz-Kasch for the most complete line of standard knobs in the industry—and SAVE. Send for samples and specification data today—or request full line data on knobs not shown. Inquiries answered at once.



*Don't overlook these popular Kurz-Kasch designs for bar knobs, pointer knobs and dual control vernier knobs.*

# KURZ-KASCH

**Specialists in Thermo-Setting Plastics for 37 years**

**Kurz-Kasch, Inc. • 1427 S. Broadway • Dayton 1, Ohio**

**BRANCH SALES OFFICES:** New York, *Mt. Vernon MO 4-4866* • Rochester, *Hillside 4352* • Chicago, *Merrimac 7-1830* • Detroit, *Trinity 3-8200* • Philadelphia, *Hilltop 6-6472* • Dallas, *Logan 5234* • Los Angeles, *Richmond 7-5384* • St. Louis, *Parkview 5-9577* • Atlanta, *Exchange 0414* • Toronto, *Riverdale 3511*

**EXPORT OFFICE:** 89 Broad St., New York City, *Bowling Green 9-7751.*

# Highlights

Ill. In the method, a liquid compound, called pentane (one of the hydrocarbons in gasoline), is placed in a quartz container and a nitrogen-containing chemical, ethylamine, is dissolved in the pentane. The container is then placed in the nuclear reactor at the Argonne National Laboratory to make the molecules radioactive for tracing studies.

**A REFINED REFRACTORY CEMENT. . . .**

. . . .said to be impervious to penetration by molten aluminum, is a development of the Electro Refractories and Abrasives Corp., 344 Delaware Ave., Buffalo 2, New York. The material is useful for the lining of furnaces in which aluminum is melted by electricity.

**50 PERCENT REDUCTION. . . .**

. . . .in the cost of finished parts may be the result of a method of bonding rubber to nylon bearings. Minnesota Rubber and Gasket Co., 3628 Woodale Ave., Minneapolis 16, Minn., report that the new technique permits the injection molding and bonding, within close tolerances, in one operation. Formerly, metal sleeves were molded into the rubber, then an oilite bearing was inserted and the rubber surfaces ground to dimension—an expensive operation.

**NEW PLASTIC . . . .**

. . . . combines the properties of polyethylene and cellophane to form a flexible, transparent laminate for the packaging field. Developer of the material, the Cheslam Corp., division of the Chester Packaging Products Corp., 284 Nepperhan Ave., Yonkers, N. Y., says: the packaging is heat sealable, moisture proof, tough and leakproof. It is laminated in varying thicknesses, ranging from 0.005-0.006 in. polyethylene combined with 300-450 weight cellophane to allow for full protection of products with the greatest economy.

## COMPONENTS

. . . .Stacked tube a new concept of an electron tube, claimed to have a high degree of stability under extreme temperatures, vibration conditions and shock has been developed by Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y. The new tube features a ceramic envelope or cap instead of the usual glass bulb. The various parts are "stacked" atop each other in the assembly process, also claimed to be a radical departure from conventional methods.

**SHEET PLASTICS. . . .**

. . . .as thin as 0.010 in. can be tested for fatigue properties by use of a new accessory fixture developed by the Sonntag Scientific Corp., Greenwich, Conn. When joined to a Baldwin-Lima-Hamilton Corp., 940 Simpson St., Eddystone, Pa., produced testing machine, the fixture guides the free end of a specimen in vertical oscillations and forces it into an S-curve or reversing S-curve at 1,800 cpm. Free horizontal movement of the fixture head—produced by strain of the specimen—is provided through two flex plates. A stress of 150,000 psi in a 0.01 in. specimen is possible with less than ¼ in. deflection and a 5¼ lb force.

**AUTOMATIC ANALYZER. . . .**

. . . .is claimed to be able to analyze up to 10 components in a sample in 10 min. Called the Multi-Component Infrared Analyzer, it is a development of The Perkin-Elmer Corp., Danbury Rd., Norwalk, Conn. Instrument time is reported to be shortened by nearly 50 per cent over manual spectrometer analyses and human errors are claimed reduced since results are typed or punched automatically on cards.

**AN INSTRUMENT. . . .**

. . . .for sonic inspection, measurement, and the control of metal engine parts is a development of Sperry Products Inc., 1000 Shelter Rock Road, Danbury, Conn. The precision instrument—which uses ultrasonics and digital automation in applying quality inspection to production line operations—costs $300,000. It is to be used by the Allison Division of the General Motors Corp. for the inspection of jet engine rotor forgings and other unfinished engine parts.

**BOLT PRELOADING. . . .**

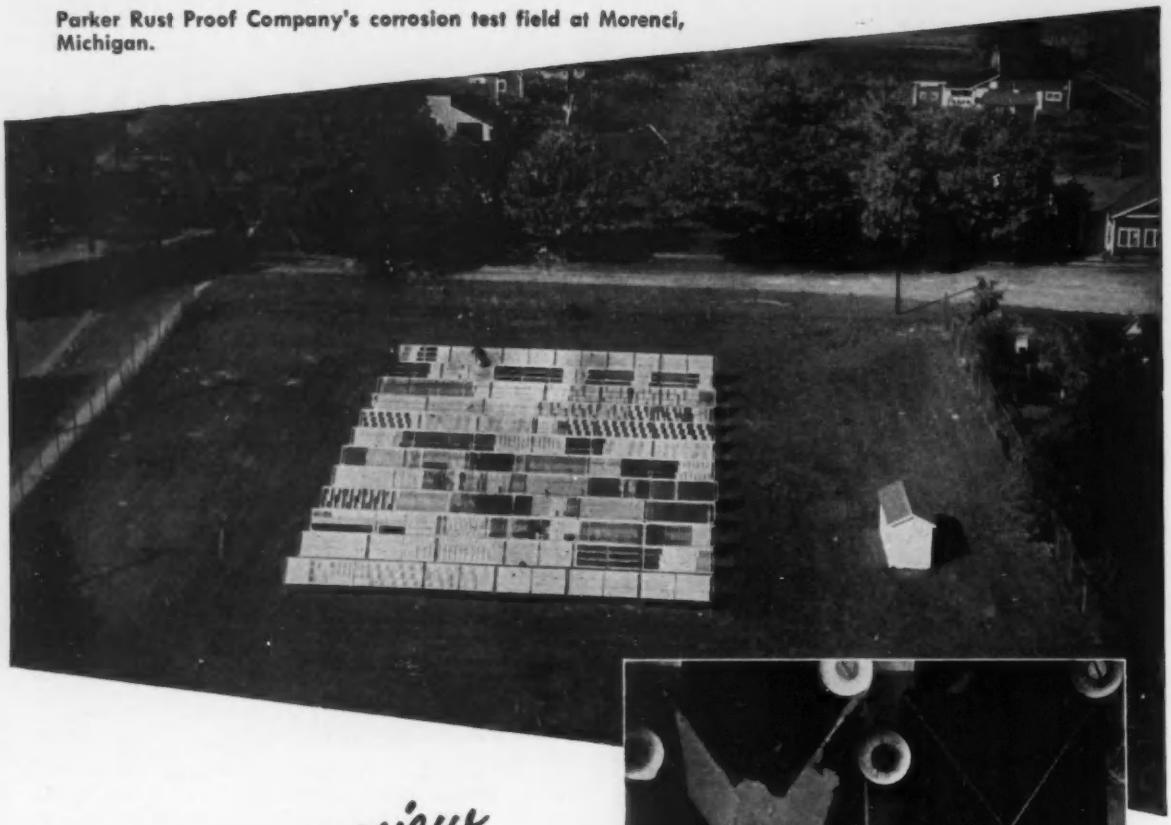
. . . .can be accomplished by use of a newly designed washer which assures an average tension of about 80 per cent of the desired bolt preload. Douglas Aircraft Co., 3000 Ocean Park Blvd., Santa Monica, Calif., claims this will increase the fatigue life of bolts and give tighter assemblies. Device consists of two concentric steel rings. Thick inner ring takes the load when the nut is tightened, allowing outer ring to move freely until the desired preload is reached. Choice of washer dimensions and material determines the load.

## PROCESSES

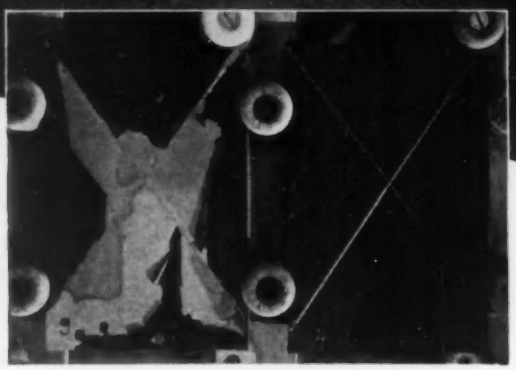
. . . .Electroplating alloy containing 75 per cent tin and 25 per cent zinc is just one of the many new developments coming out of the Tin Research Institute, Fraser Road, Perivale, Greenford, Middlesex, England. In addition to providing superior corrosion resistance for steel, it is claimed that the alloy lends itself to soldering. Steel coated with the alloy is being

(*continued on page 9*)

Parker Rust Proof Company's corrosion test field at Morenci, Michigan.



# Birds-eye view of a strange crop



What weather does to finishes! Panel left, paint over untreated aluminum. Panel right, paint over Bonderite-treated aluminum. 11 months outdoor exposure.

A crop of 6,400 metal panels is tended in Parker Rust Proof's outdoor test field. The harvest is facts on the durability of various finishes over various metals.

Conditions here are the same as are met by painted products in daily outdoor use. The sun and the wind, the rain, sleet and snow pound at these panels continually. Parker technicians watch each set of panels individually, observe their condition, chart results at regular intervals.

This large-scale outdoor testing program, continuous since 1935, has helped build Parker's great fund of valuable information on how to control corrosion. The facts we learn from the corrosion test field are passed on to guide our customers to more effective, more economical surface treatments for metals.

*Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.

Since 1915—leader in the field

**PARKER RUST PROOF COMPANY**

2179 E. Milwaukee Ave., Detroit 11, Michigan

| BONDERITE | BONDERITE and BONDERLUBE | PARCO COMPOUND | PARCO LUBRITE |
|---|---|---|---|
| corrosion resistant paint base | aids in cold forming of metals | rust resistant | wear resistant for friction surfaces |

# Highlights

assembled with aluminum parts without any ensuing electrolytic deterioration. Other developments include: new coating for brass which is highly resistant to tarnishing; and a white alloy—15 per cent Mn, 8 per cent Zn, remainder Cu-intended as an alternate to nickel-silver combinations.

METAL CLADDING. . . .

. . . .which can be applied to any surface at room temperature and, is said to impart a hardness and abrasion-resistance almost equal to metallic tungsten, is a development of the Lockrey Co., Southampton, New York. Where extreme dimensional accuracy is important—for instance on a casting—the coating may be brushed on the surface of the mold itself and cured integrally with the casting resin poured against it. The finished casting comes out of the mold with the metallic tungsten hard surfacing built in. Coating may also be applied directly to any wear spots on the finished mold or part, and then polished. This builds up the mold and protects it against further wear.

NEW CARBIDE. . . .

. . . .that is said to extend the machining range of carbides to withstand cutting temperatures as high as 1,800 F has been developed by the Carboloy Dept., General Electric Co., 11155 E. Eight Mile Rd., Detroit 32, Mich. The material is for use in light roughing and general finishing and is claimed to provide up to 30 per cent better performance than existing carbides in this machining area. Also, it is considerably tougher than the present high wear-resistant carbides.

IRREGULAR SHAPES. . . .

. . . .can be stretch formed by the addition of a transversing or wiping motion to the side pressure shoe. The Cyril Bath Co., Solon, Ohio, states that the addition of a hydraulically operated side pressure shoe to the basic rotary stretch former permitted greater forming accuracy. The shoe is located at the point of tangency between the work piece and the die. However, without the transverse motion, the shoe action is limited to arcs and circles in fabricating.

NICKEL PLATING . . . .

. . . . directly on raw or anodized aluminum, to give an erosion-resistant surface and materially strengthen the aluminum is a development of the Bart Laboratories Co., Inc., 222 Main St., Belleville 9, N. J. It is claimed that when nickel is deposited to both surfaces of aluminum sheet, the sheet is greatly strengthened without materially increasing the weight. The process is said to eliminate the need for an intermediate bonding material—such as copper or adhesive cement—between the aluminum and the nickel.

## TESTING

. . . .Transparent models are being used for the study of fluid flow in molds to examine downsprues, runner systems and general gating systems. Metallurgists at the General Motors Research Laboratories, General Motors Bldg., Detroit, Mich., report that the mold pattern for the part is made from a low melting point alloy. A liquid, cold-pouring, thermosetting plastic is then poured around the pattern. When the plastic has set, it is heated until the metal pattern melts and drains out. After the last traces of metal are cleaned out with acids, the mold is transparent and ready for use in flow studies.

A LEAK DETECTION . . . .

. . . . technique has been devised which is said to enable the discovery of a leak so small that it would take a year to form a single drop. According to the Babcock and Wilcox Research Center, Harrisburgh & Sawburg Rds., Alliance, Ohio, the unit is the result of the investigations of materials to be used in atomic energy applications where a leak could be deadly. The method is: to fill the test vessel with helium and then, through the use of a mass spectrometer leak detector, measure the amount of helium that escapes into the surrounding atmosphere. It is possible to detect one part of helium in 200,000 parts of air.

PREALLOYED STEEL POWDER. . . .

. . . .for high strength powder metallurgy applications is the result of research of the Vanadium-Alloys Steel Co., Toolsteel St., Latrobe, Pa. High strength parts can be produced—according to the company—by briquetting and sintering without resorting to secondary treatments any more elaborate than simple hardening. A nickel-molybdenum composition, the powder has excellent green strength and is readily moldable at low pressures to yield dense, strong comparts. Other characteristics include: ease of heat treatment and toughness comparable to alloy steel characteristics.

BETTER ALUMINUM CASTINGS . . . .

. . . . are possible by the complete removal of microporosity. Sound cast metals have more than double the yield strength and improved tensile strength and elongation, according to scientists at the Massachusetts Institute of Technology, Cambridge 39, Massachusetts. Improvements are accomplished by degassifying the molten metal prior to casting. A quick test for determining the gas content has been developed. A test button is allowed to solidify under a pressure of 1/10 atmosphere. If the molten metal contains a harmful amount of gas—usually hydrogen—a very porous button is obtained. If the amount of gas present is small, the cast button is sound with improved strengths.

**NEW *Norgren* REGULATORS give close, constant pressure control of cylinder gases . . .**

## . . . *plus* EASIER MAINTENANCE *and a lot less of it!*

Norgren 1-stage Cylinder Gas Regulators are specially built to regulate the pressure of cylinder gases, from tank supply to point of use, as accurately as most 2-stage types. Outstanding features include: close control in reducing tank pressures of up to 3000 psi. to delivery pressures from 2 psi. to 450 psi.; positive delivery pressures without "creep"; exclusive ball-pivoting lower spring rest which assures permanently friction-free operation; available with maximum delivery pressures of 50, 75, 175 or 450 psi.

### FOR USE ON FOLLOWING GASES:

Carbon Dioxide
Nitrous Oxide
Nitrous Oxide and Carbon Dioxide Mixtures
Carbon Monoxide
Ethane
Ethylene (Industrial)
(Medical)
Hydrogen
Methane

**WATER PUMPED:**

Air
Argon
Helium
Krypton
Neon
Nitrogen
Xenon

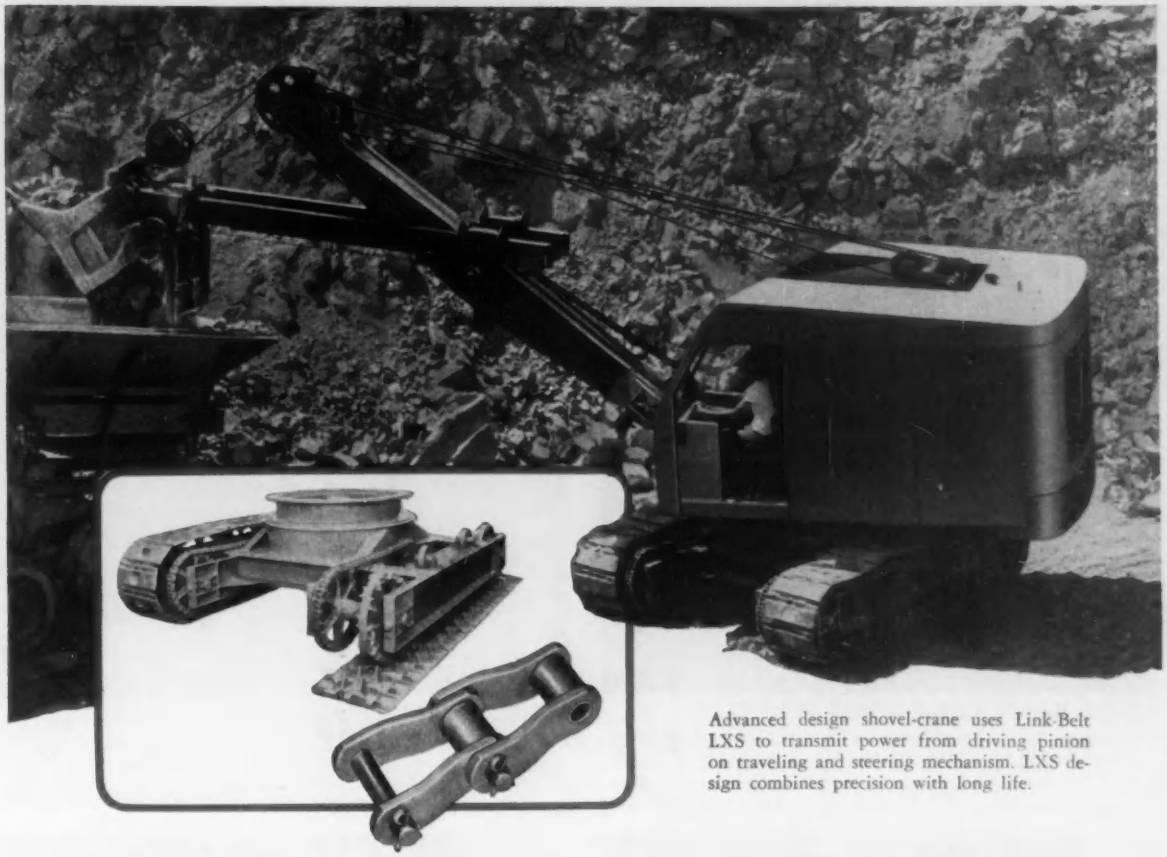
***Manufacturers of Quality Pressure Regulators for more than a Quarter of a Century***

PIONEER AND LEADER IN OIL FOG LUBRICATION FOR 26 YEARS

**WRITE FOR COMPLETE DATA**

C. A. *Norgren* CO.
3428 So. Elati, Englewood, Colo.

Valves • Filters • Regulators • Lubricators • Hose Assemblies



Advanced design shovel-crane uses Link-Belt LXS to transmit power from driving pinion on traveling and steering mechanism. LXS design combines precision with long life.

# For heavy-duty, exposed drives -- it's LINK-BELT LXS chain

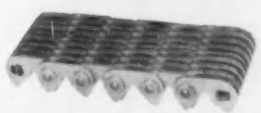
## LINK-BELT offers the chain that's best for every drive and conveying job

Accurate sizing of pins, bushings and pitch holes in Link-Belt LXS chains assures a tight fit of mating parts. This plus many other important features promotes longer chain life. That's why they are so widely used for exposed drives subject to repeated heavy loads and high impact.

Similarly, for other types of power transmission and conveying, Link-Belt builds chains with the characteristics required by the job. And it's this completeness of line that gives you the *right* chain for *your* requirements.

Ask your nearest Link-Belt office for the facts on the complete Link-Belt line of chains and sprockets, including roller and silent chain drives.

**No ONE chain serves every purpose -- get the RIGHT one from Link-Belt's *complete* line**



Link-Belt Silent Chain for smooth, high-speed drives from fractional to thousands of horsepower. Preselected stock drives to 50 hp.

Precision Steel Roller Chain combines high hp with light weight for drives and conveyors. Single and multiple widths, ⅜ to 3" pitch.

Double-Pitch Precision Steel Roller Chain for conveying and power transmission applications.

S-815 flat-top conveyor chain—economical, sturdy, reliable, easy to detach and keep clean.

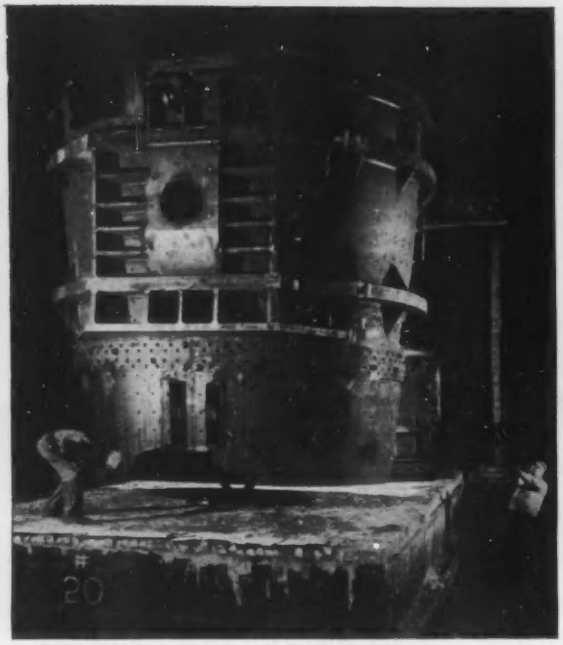
13,561-B

LINK-BELT

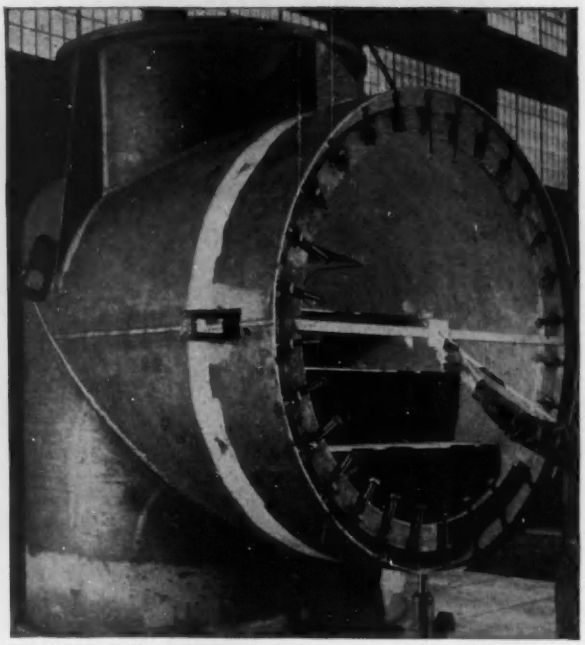
CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

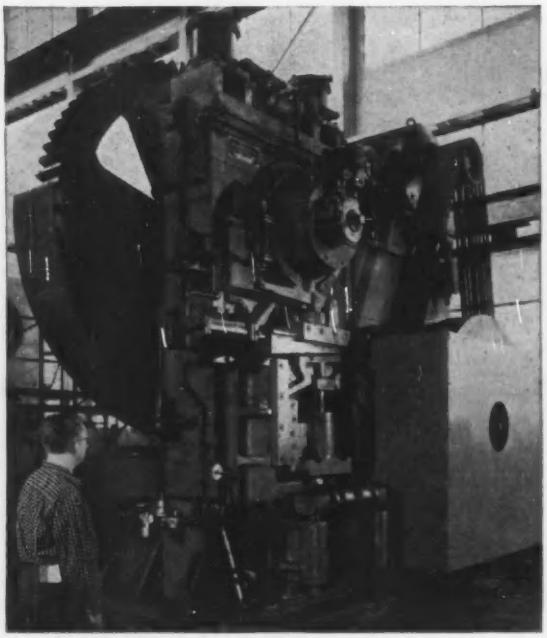
# WHAT'S NEW IN WELDMENTS



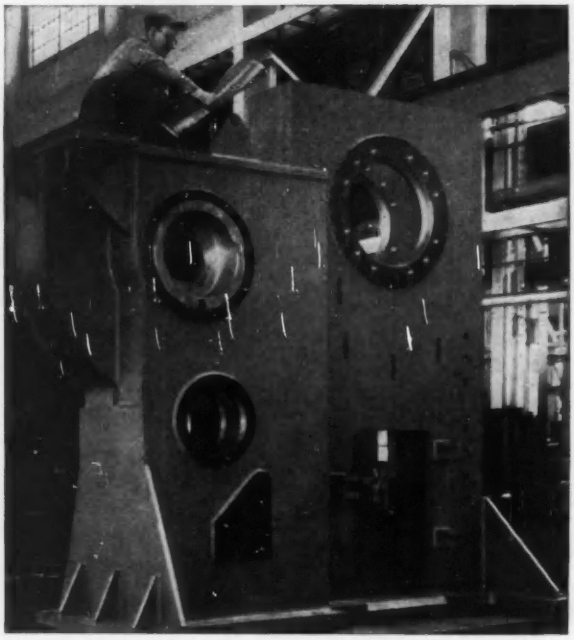
**THEY DON'T COME MUCH BIGGER**—This 265-ton-capacity ladle, on its way into a stress-relieving furnace, weighs 50 tons and stands 16 ft high. Among the world's largest, it will be used in the open-hearth department of our Sparrows Point (Md.) Plant.



**THREE-TON PUMP ELBOW**—Some tricky welding went into this big hydrofoil-pump elbow, shown with a rounding-up jig. Dimensions: 72 in. ID, 102 in. over-all height, ½ in. shell thickness. We're old hands when it comes to any type of welded platework.



**POWERFUL BILLET SHEAR**—Nominally rated at 700 tons, this big mechanical shear handles billets up to 6 in. x 6 in. with ease. The entire assembly tips the scales at over 60 tons and stands 180 in. high. It is one of several shears designed, fabricated and assembled by Bethlehem for a leading auto company. Shown above is the shear's 17-ton main frame. It was constructed of rolled plates up to 5½ in. thick, welded together to form a rugged, rigid assembly. Bethlehem also manufactured and machined the forged and cast parts.



*For further information about Bethlehem Weldments, call on the nearest Bethlehem sales office.*

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

*On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation*

BETHLEHEM STEEL

# BEARING PROBLEM?

First large Tricone mill ever built by Hardinge Company grinds 2000 tons of ore per day. Pinion shaft is supported by two Link-Belt Series 6800 Roller Bearing Pillow Blocks.

# READY ANSWER:

## LINK-BELT roller bearings chosen for huge grinding mill

INSTALLATION of this Hardinge Tricone mill at Tennessee Copper Co. resulted in an important conservation of grinding energy. And to support the pinion shaft drive, Hardinge designers chose Link-Belt roller bearing pillow blocks.

Wherever friction must be minimized and power consumption reduced, you'll find Link-Belt bearings. Precision-built and positively sealed, they deliver long-life, free-rolling shaft support on the toughest jobs. That's why they're first choice of so many leading design and consulting engineers.

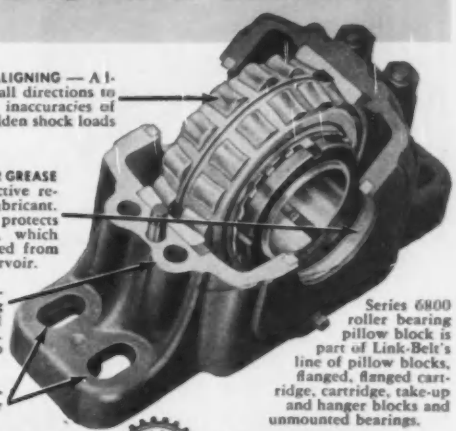
You'll find there's a Link-Belt ball or roller bearing for every industrial need. And there's a Link-Belt bearing engineer near you to help apply them to your particular requirements. Call him today, or write for your copies of Data Books 2550 and 2565-A.

**FREE-ROLLING SELF-ALIGNING** — Adjusts immediately in all directions to shaft deflections and inaccuracies of mounting. Heavy, sudden shock loads are no problem.

**LUBRICATE WITH OIL OR GREASE** — Seals provide effective retention of either lubricant. Housing sealing fully protects all moving surfaces, which are centrally lubricated from a large, common reservoir.

**SIMPLIFIED INSTALLATION** — Split housing cap can be removed with standard tools. Inspection is also readily accomplished.

**EASY LATERAL ADJUSTMENT** is provided by slotted bolt holes.



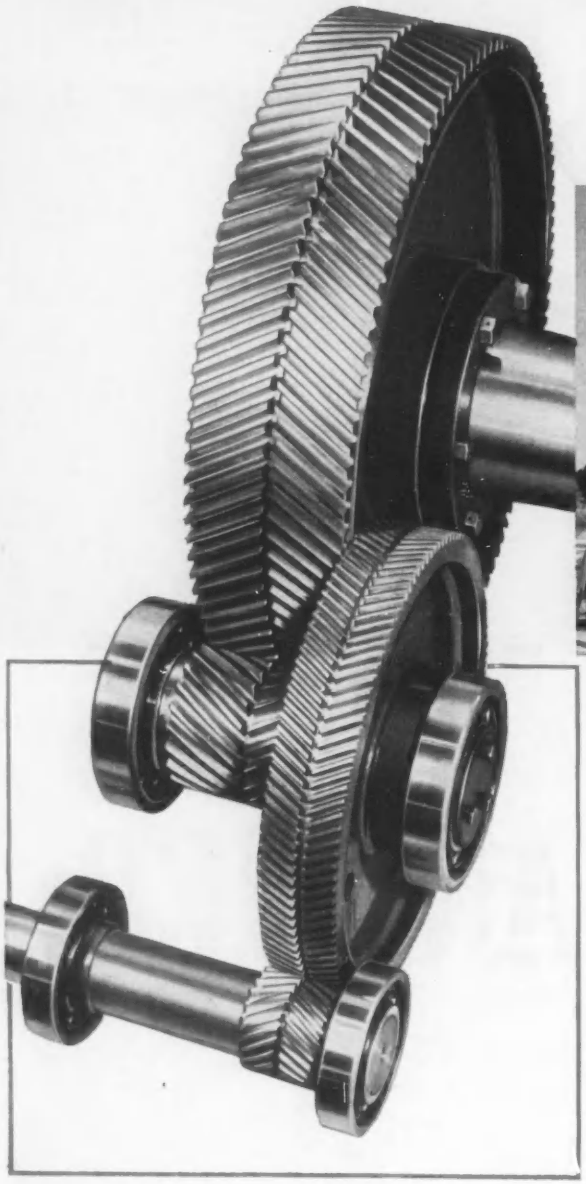
Series 6800 roller bearing pillow block is part of Link-Belt's line of pillow blocks, flanged, flanged cartridge, cartridge, take-up and hanger blocks and unmounted bearings.

LINK-BELT

**BALL AND ROLLER BEARINGS keep company with industry's hardest-working machines**

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 15 531-B

# FLOATING ON HYATTS!



## This is a job for straight roller bearings, and EMSCO relies on HYATTS!

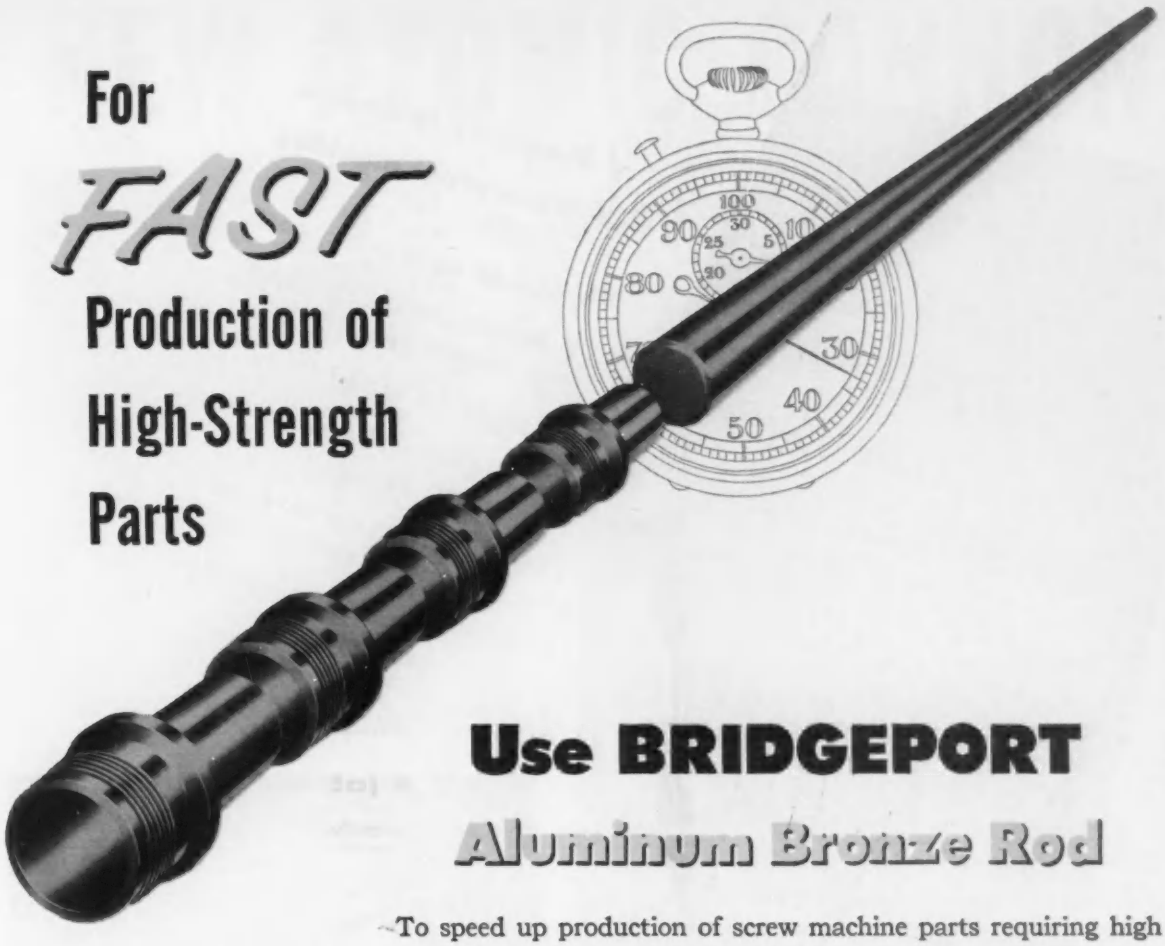
Take a good look at these herringbone gears—and at the four bearings supporting the two smaller shafts. These particular herringbones operate in the gear box of EMSCO's newest pumping unit, and the bearings are *Hyatt Hy-Loads!* For oilmen, this is a combination that means longer bearing life and lower maintenance costs, because only *straight radial bearings* permit these gears to locate themselves for most efficient operation. And when the application calls for radial-type bearings, EMSCO engineers specify Hyatts. Hyatts offer the proven advantages of easy assembly, simple maintenance, complete interchangeability of parts, and longer life. Insist on Hyatt Hy-Load Bearings for herringbone gear applications.

# HYATT ROLLER BEARINGS

STRAIGHT ○ BARREL ○ TAPER ○

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

# For *FAST* Production of High-Strength Parts



## Use BRIDGEPORT Aluminum Bronze Rod

- machines 50 to 75% as fast as Free-cutting Brass.
- has 85,000 psi tensile strength.
- gives superior resistance to corrosion and wear.
- is 50% stronger—9% lighter than Naval Brass.

To speed up production of screw machine parts requiring high strength and outstanding durability, use Bridgeport Aluminum Bronze, Alloy 707. It gives superior service in wire and cable connectors, bolts, nuts, gears, pump parts and many other applications where dependability is a vital requirement.

Bridgeport Aluminum Bronze is one of a wide variety of Bridgeport Alloys that meets almost every screw machine requirement. Your nearest Bridgeport Sales Office can give you complete information on any Bridgeport Alloy and also offer you the advantages of our Technical Service to help you solve methods and metals problems.

*Write for your copy of Bridgeport's Manual on Aluminum Bronze and other high-strength alloys.*

**BRIDGEPORT BRASS**
**COMPANY • BRIDGEPORT, CONNECTICUT**

*Serving Industry With a Nationwide Network of Conveniently Located Sales Offices and Warehouses*

**Mills at Bridgeport, Conn., Indianapolis, Ind., and Adrian, Mich.**
***In Canada: Noranda Copper and Brass Limited, Montreal***

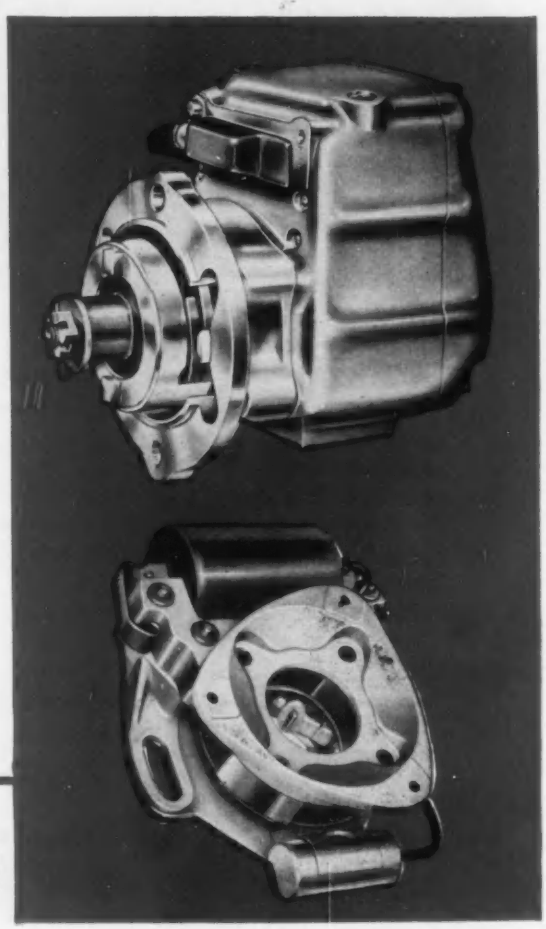
WOULD YOU LIKE
LONGER LIFE
and FREEDOM
from BREAKDOWNS
IN YOUR SMALL ENGINES?

Specify

BENDIX

THE MOST TRUSTED NAME IN MAGNETOS

✓ Simplicity in design.
✓ Waterproof moulded coil.
✓ Lower operating cost.
✓ Minimum lubricating requirement.
✓ Light in weight.
✓ Higher voltage at starting speed.
✓ Constant spark over entire speed range.
✓ Compact and sturdy construction.



Whether you purchase a small engine for outboard, industrial or marine use, today's foremost consideration should be long life and trouble-free performance. Therefore, it will pay you well to insist on Bendix magnetos in the engine you select. For the basic design of Bendix magnetos assures quality performance for *every type* of small engine and *every pricing requirement.* Remember it pays to specify Bendix, the most trusted name in magnetos. Complete information available on request.

Bendix
SCINTILLA DIVISION of Bendix AVIATION CORPORATION
SIDNEY, NEW YORK

FACTORY BRANCH OFFICES: 117 E. Providencia Avenue, Burbank, California • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan • 512 West Avenue, Jenkintown, Pennsylvania • Brauner Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California • EXPORT SALES: Bendix International Division 205 East 42nd Street, New York 17, New York

# NEW ATOMIC CANNON

Added Evidence that—

## Everyone Can Count on VEEDER-ROOT

This mobile 280 mm. atomic cannon has *two* recoil motions. The primary recoil absorbs the cannon's "kick". The secondary recoil (something new in artillery) absorbs the forces created by the primary recoil. And each recoil motion is recorded by this special Veeder-Root Counter designed with a plunger-action shaft . . . which keeps the score on the cannon's use and indicates approaching need for maintenance.

This again points up the fact that "Anything Worth Making — or Worth Doing — *Is Worth Counting*." And Veeder-Root has the experience and resources *you* can count on, to give you any counter you need . . . for any mechanical or electrical application . . . in any field from Atomics to Automation. Write:

**VEEDER-ROOT INCORPORATED**
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

**"The Name that Counts"**

# SMASH go

## Outlasts, outperforms any

# NATIONAL Micro OIL

**Lowest Torque**

**Highest Lubricity**

**No Measurable Leakage**

**Runs Cool, Lasts Longer**

**Sealing Lip Stores Oil**

New National Micro-Torc Oil Seals, developed and offered only by National, absorb less power and last longer than any leather oil seal ever made. Properly employed, National Micro-Torc seals have *no measurable leakage throughout service life.*

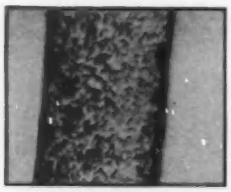


Figure 1
National Micro-Torc sealing member with "storage action"

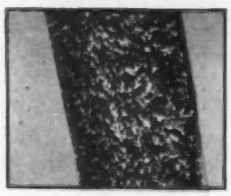


Figure 2
Leather seal impervious because of complete rubber impregnation

National Micro-Torc sealing members are coated with an elastomer of high lubricity through which lubricants cannot pass, (Fig. 1). However the body of each sealing member retains its natural porosity. Thus, Micro-Torc sealing members absorb and store lubricant while permitting none to escape. This feature alone makes Micro-Torc the outstanding seal for starved or semi-starved applications.

©1954 National Motor Bearing Co., Inc.

# performance records!

## leather oil seal ever made!

# -Torc SEALS

TRADE MARK

This is in sharp contrast with present-day leather seals which tend to saturate and leak, or completely rubber-impregnated leather seals (Figure 2) which are impervious to oil and can neither absorb nor store lubricant for periods when lubricant is not otherwise supplied.

### TESTS SHOW SUPERIORITY

In a continuing series of identical 1,000 hour tests at National Motor Bearing Co., the marked superiority of National Micro-Torc Oil Seals over present day leather seals has been clearly demonstrated. Completely rubber-impregnated seals showed an average leakage of 1 to 5 grams per day. In addition, these seals hardened and became brittle after only 200 hours operation at 170° F.

By contrast, 90% of Micro-Torc seals tested *had no measurable leakage at all.* (Figure 3) Test conditions throughout the 1,000 hours were identical in every respect. At the end of the run, *every National Micro-Torc Seal was flexible and fully operative.*

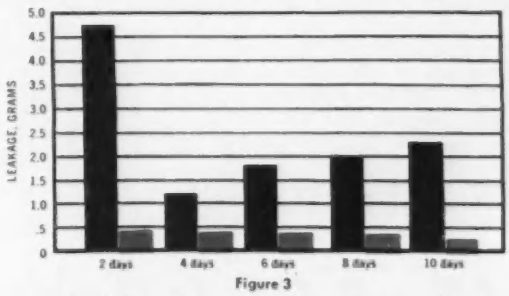



Figure 3

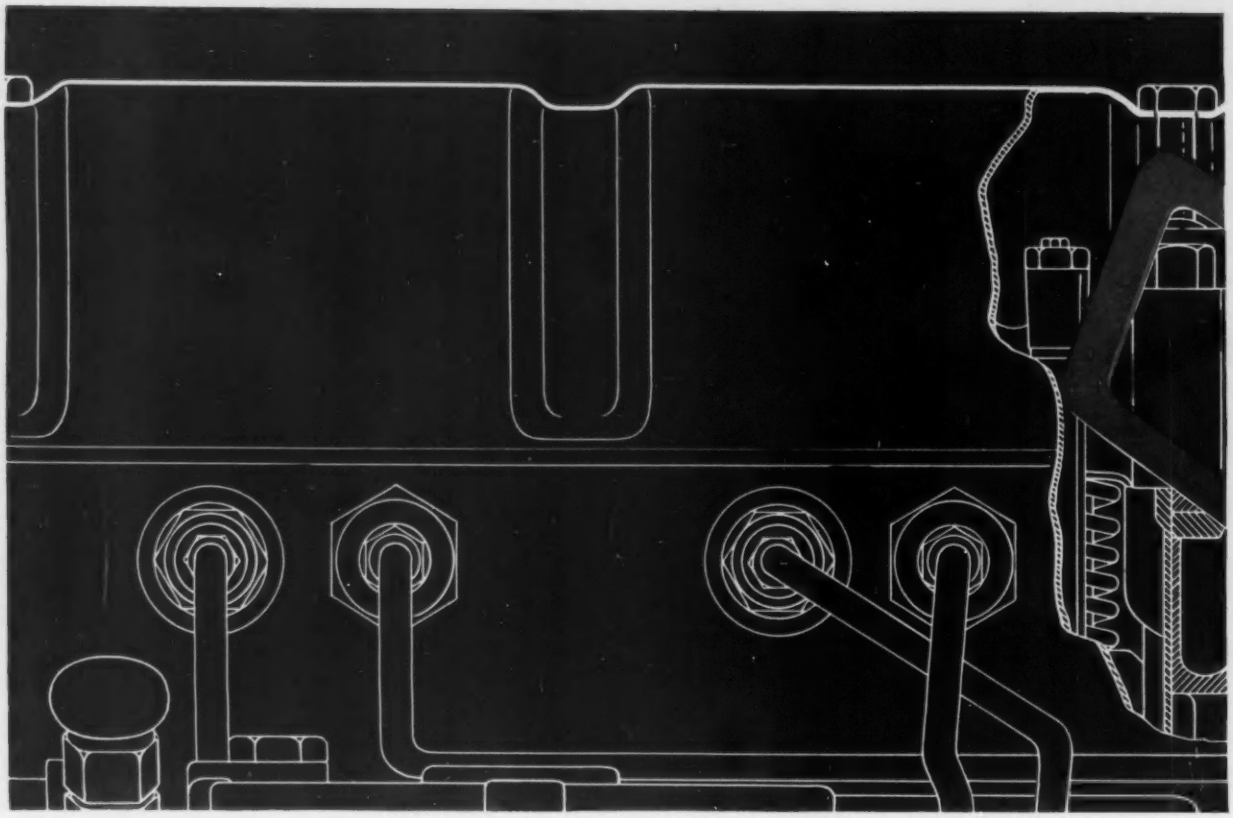
Zero-leakage performance of National Micro-Torc seals ■ in comparison with rubber-impregnated leather seals ■

### TECHNICAL BULLETIN

Describes National Micro-Torc in detail, contains test results, performance charts. For your free copy, write Dept. A.

3122

**NATIONAL MOTOR BEARING CO., INC.**
**General Offices:** Redwood City, Calif.
**Plants:** Redwood City, Calif.; Van Wert, Ohio



# improved fiber gasket seals perfectly with low bolt pressure

To seal a stamped flange under the low bolting pressures normally available requires a gasket with unusual compressibility.

The gasket for the stamped rocker lever cover on this diesel engine is a typical case. The original gasket leaked because it lacked compressibility and squeezed out of position on the narrow flange.

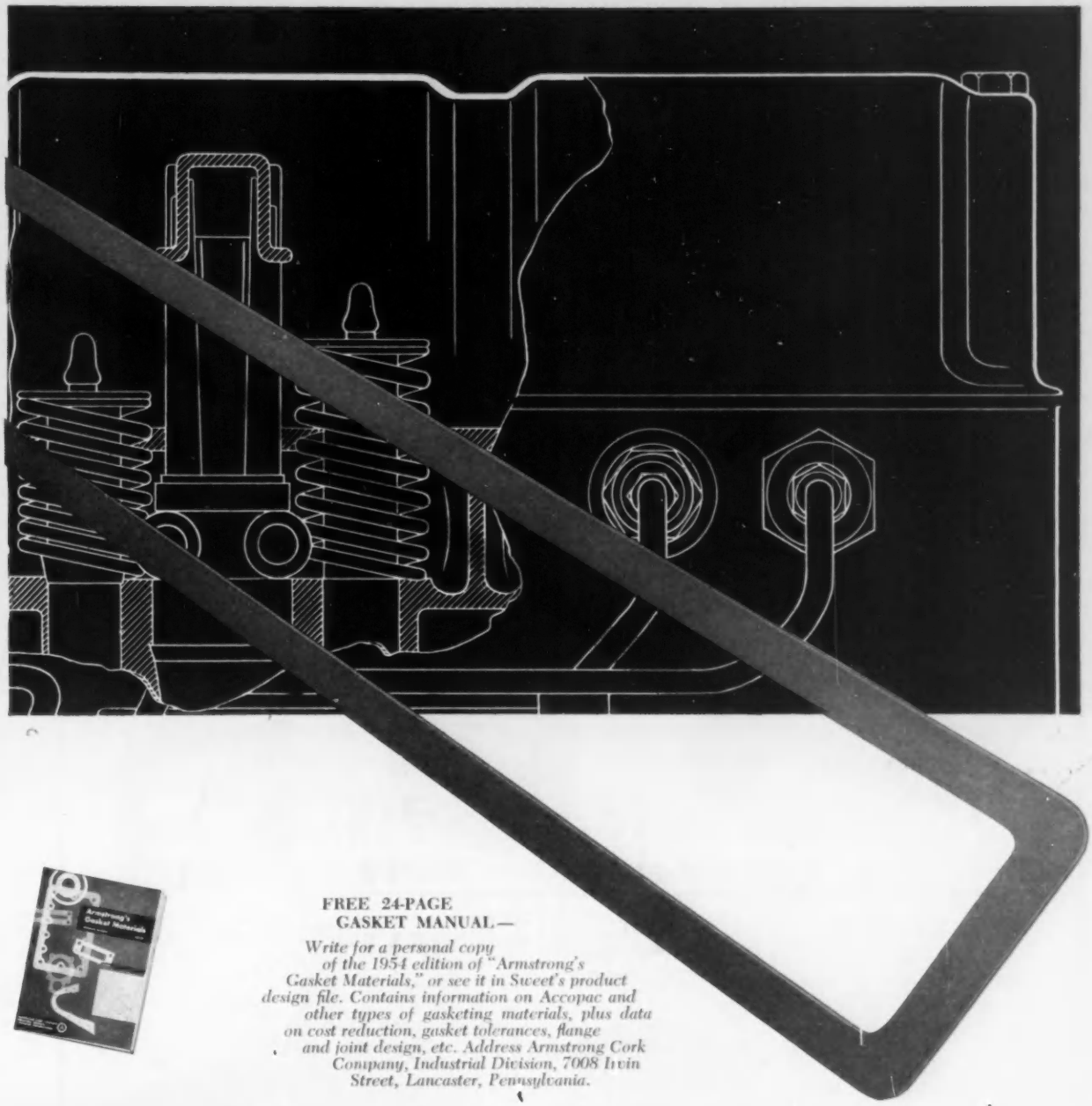
When the engine manufacturer switched to a brand-new fiber gasketing material—Armstrong's CN-705 Accopac®—the leaks stopped. Accopac—a unique combination of fiber, rubber, and cork—had the required compressibility. And surprisingly, it cost less than the material it replaced.

This superior performance results from the way Accopac is made. In a patented modification of the beater saturation process, cork particles, fiber, and rubber are literally locked together into strong, uniform sheets. The material is highly compressible, yet it resists crushing—Accopac compounds withstand test pressures up to 100,000 psi, while conventional top-grade fiber material often crushes under a load of 25,000 psi.

Gaskets cut from Accopac will not dry out, crack, or shrink in any recommended application. The latex binder is non-volatile and non-extractable. And because Accopac is virtually unaffected by variations in temperature and humidity, gaskets retain their dimensional stability even after months of storage.

Although it is a relatively new material, Accopac has had wide acceptance in hundreds of applications where a dependable, low-cost seal is needed. It is being used in pumps, engines, appliances, aircraft, automotive equipment, and a wide variety of industrial applications. Where can *you* use Accopac?

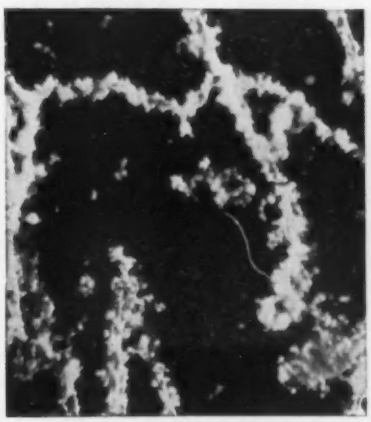
## ARMSTRONG'S ACCOPAC





**FREE 24-PAGE GASKET MANUAL—**

*Write for a personal copy of the 1954 edition of "Armstrong's Gasket Materials," or see it in Sweet's product design file. Contains information on Accopac and other types of gasketing materials, plus data on cost reduction, gasket tolerances, flange and joint design, etc. Address Armstrong Cork Company, Industrial Division, 7008 Irvin Street, Lancaster, Pennsylvania.*



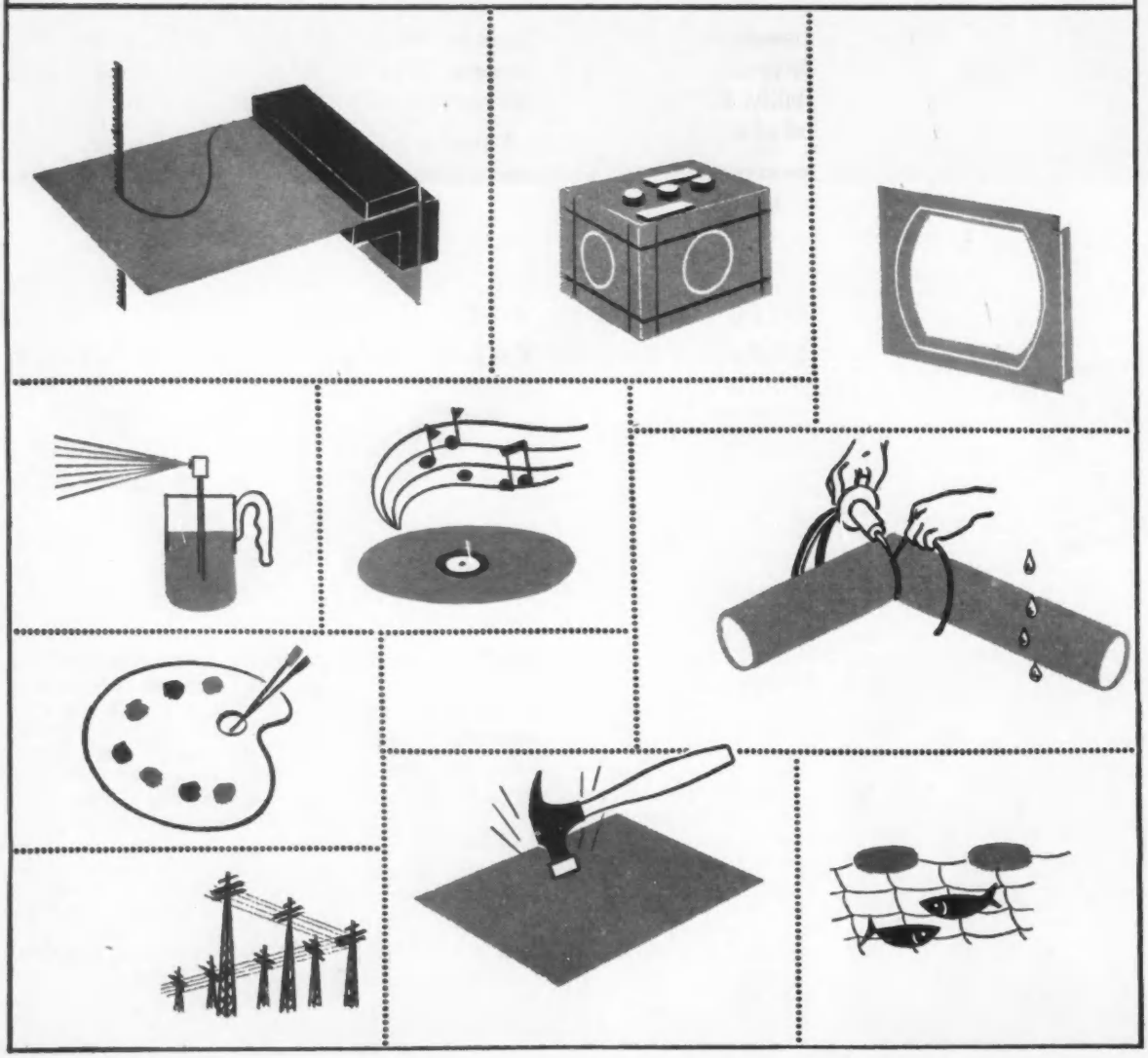
**KEY TO SUPERIORITY.** This photomicrograph shows what happens when Accopac is compounded. Fibers, latex, and cork particles combine to form a completely uniform material before sheets are formed. Resulting material is resilient, stable, and thoroughly impermeable for long, trouble-free life.

**COMPRESSIBILITY PLUS.** The Accopac gasket on the right withstood pressures of 100,000 psi without damage, while conventional top-grade fiber on the left crushed by 25,000 psi. This compressibility, combined with dimensional stability, makes Accopac ideal for sealing tightly on any size flange.

# Firestone

## helps industry achieve

**Versatile EXON Resins are performing for America's Leading Manufacturers in many fields!**



# greater quality at less cost.

## ...with the ever-growing line of

# EXON RESINS!

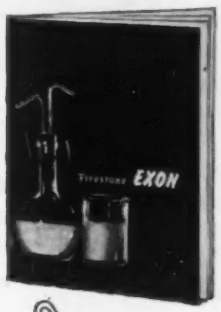
Each new EXON Resin is welcomed by industry as the basis for easily processed materials having excellent workability. EXON Resins have a remarkable record of achievement.

EXON is creating new standards of durability. Applications once requiring *combinations* of resins now rely on a *single* EXON Resin to deliver products of outstanding performance. EXON *cuts processing time and raw material costs . . . for shortcuts to profits!*

Whatever your specifications . . . for toughness, chemical inertness, heat and light stability, superior EXON Resins assure superior results!

### MANY MANUFACTURERS NOW PROFIT FROM FIRESTONE'S EXPERT TECHNICAL COUNSEL

The complete story on the many uses of EXON Resins is presented in Firestone's colorful new EXON Booklet. Write for free copy today!



Supplementing the uses of EXON Resins, Firestone offers valuable technical service embracing . . .

* Highly skilled technicians to help design compounds based on EXON Resins for specific applications.
* Facilities for testing physical properties.
* Facilities for testing chemical properties.
* Facilities for testing aging properties.
* Facilities for conducting specific application tests.

For further information or consultation on the entire EXON line and its processing . . . call or write

**CHEMICAL SALES DIVISION**

Firestone Plastics Co., Pottstown, Pa., Dept. 6D, Division of Firestone Tire & Rubber Co.

Solve Design and Production Problems with

# Roll Formed Aluminum Shapes from Reynolds

Roll formed shapes offer economy, dimensional accuracy, better finishes and design flexibility. They are available in a wide range of shapes that are easily bent, welded, assembled and generally fabricated. Add the many advantages of light, strong, non-rusting, low cost aluminum and it's easy to see why so many of today's top designs call for roll formed aluminum shapes.

## HERE'S WHY IT PAYS TO CALL ON REYNOLDS ALUMINUM FABRICATING SERVICE FOR YOUR ROLL FORMED ALUMINUM SHAPES

Experienced, competent help on your design problems is readily available from Reynolds design and engineering service. Capacity for prompt, economical production of your roll formed shapes is also assured—thanks to Reynolds sizable investment in roll forming machines and tooling. And, quality control from mine to finished part is still another "reason why" for obtaining your roll formed shapes from Reynolds.

Look into the advantages of roll formed aluminum shapes from Reynolds. Contact your Reynolds office listed under "Aluminum" in your classified telephone directory or write Reynolds Aluminum Fabricating Service, 2051 South Ninth Street, Louisville 1, Kentucky.

Write for your free copy of the new catalog "Aluminum Roll Formed Shapes By Reynolds"

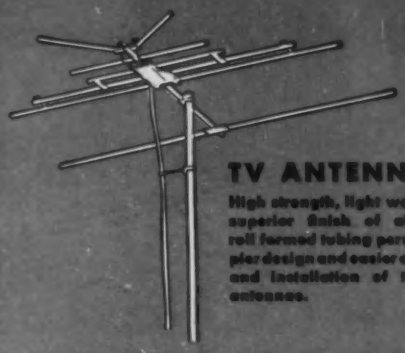
See "Mister Peepers," starring Wally Cox, Sundays on NBC-TV.

**AUTOMOBILES**

**Complex shapes required for automobile parts and trim are easily and economically produced by roll forming. Close tolerances present no problem with this process.**

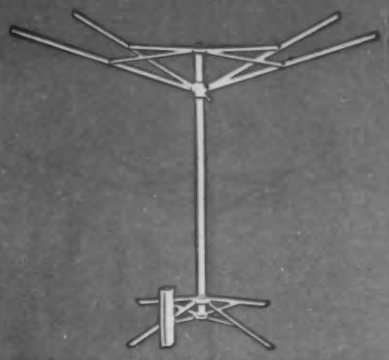
REYNOLDS ALUMINUM

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING



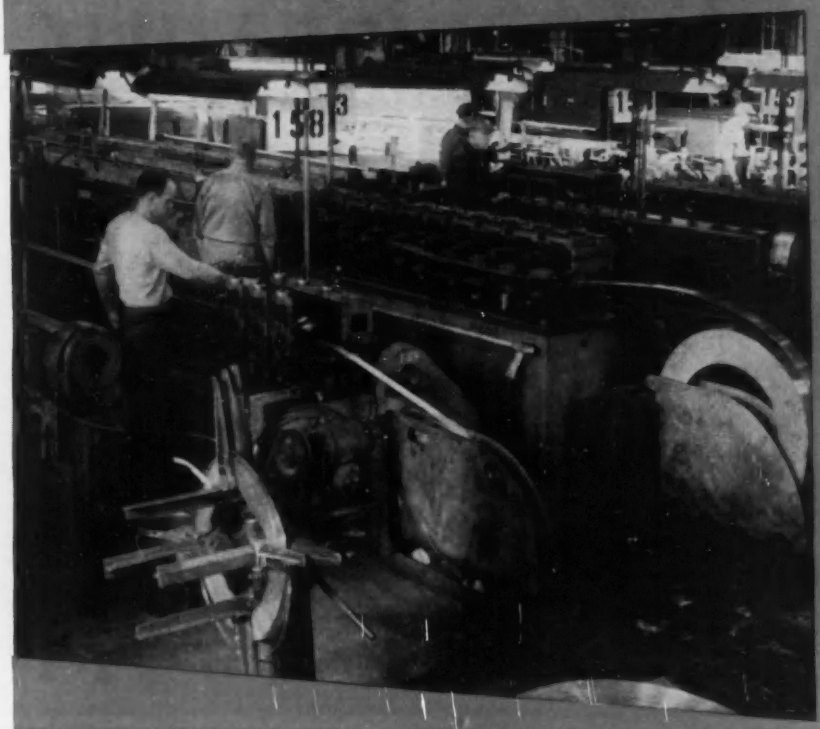
## TV ANTENNAE

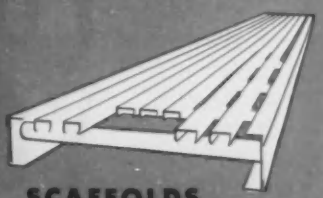
High strength, light weight and superior finish of aluminum roll formed tubing permits simpler design and easier assembly and installation of these TV antennae.



## CLOTHES DRYERS

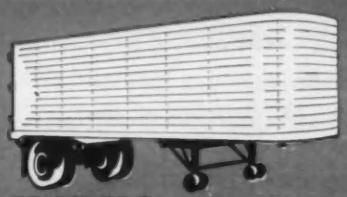
Roll formed shapes permit smoother finishes—eliminate need for finishing operations in these clothes dryers. Fine finishes required for decorative trim on metal furniture, counters, etc., are easily obtained by roll forming.





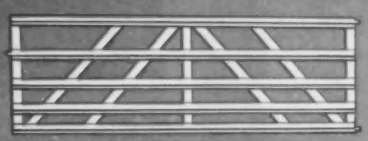
## SCAFFOLDS

The sturdy appearance of aluminum roll formed shapes helps build rapid market acceptance for these scaffolds and countless other products.



## TRAILERS

This all-aluminum trailer body uses many strong, attractive, easily assembled roll formed shapes. Aluminum's light weight and durability make it the ideal metal for such uses.



## RANCH GATES

High strength and resistance to corrosion eliminate maintenance on these farm gates made from aluminum roll formed shapes by Reynolds.

# FABRICATING SERVICE

ROLL SHAPING • TUBE BENDING • WELDING • BRAZING • FINISHING

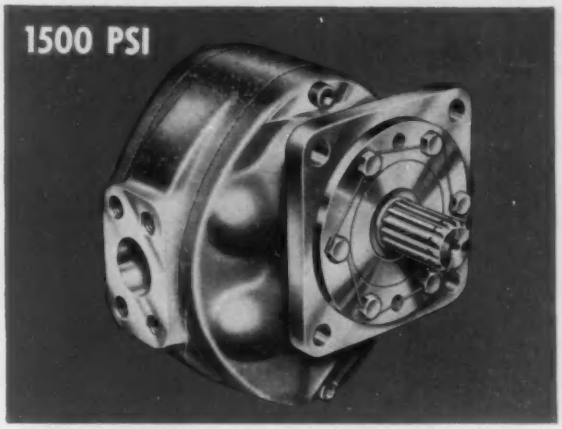
# FOUR...

# COMPLETELY NEW LINES OF HYDRAULIC PUMPS WHICH GIVE YOU FAR MORE IN PERFORMANCE AT FAR LESS IN COST!

- Pumps to give new life to existing equipment . . . to improve performance, increase capacity!
- Pumps that afford the design engineer the basic equipment for entirely new concepts in hydraulically operated machines!
- Pumps for machines to do work better, quicker, cheaper!

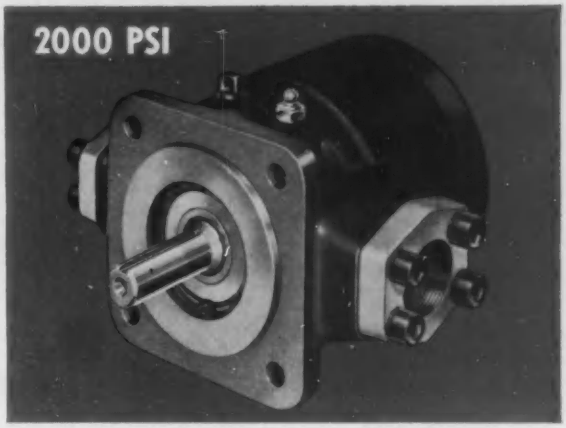
THE NEW YORK AIR BRAKE COMPANY

1112 EAST 222nd STREET • CLEVELAND 17 • OHIO



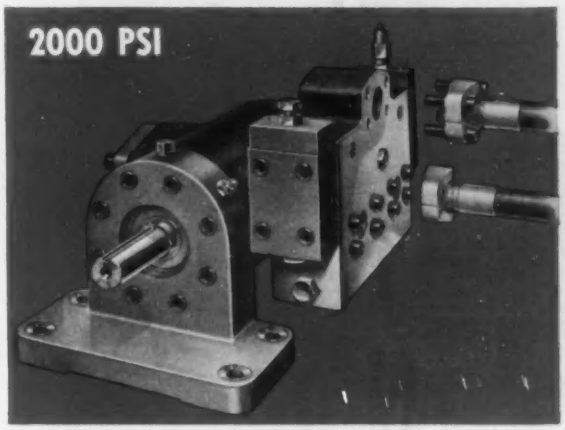

## SERIES H GEAR-TYPE PUMPS

The HYDRECO Series H Pumps are intended for use in the hydraulic systems of heavy-duty mobile and industrial equipment, especially where shock loads, impact and rugged service are "normal working conditions". Four sizes (40, 50, 60, 70 gpm) deliver fluid power at 1500 psi . . . increased horsepower gives greater work output. *Pressure-Balanced* wear plates reduce oil slippage and eliminate power-robbing frictional contacts. SAE Flange Mounting and split-flange hose connections make servicing simple and reduce down-time. Equipment is on-the-job longer.



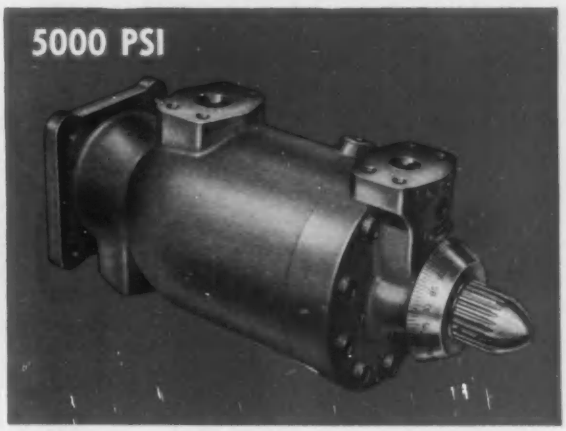

## SERIES PF-100 VANE-TYPE PUMPS

DUDCO PF-100 Series Pumps can double the value of your *hydraulic dollar*. You get 2000 psi continuous duty, single-stage construction for the cost of equal capacity low pressure pumps . . . improved equipment design and increased machine efficiency without the payment of premium prices. These Pumps feature a simplified, 3-unit construction . . . the pumping cartridge incorporates the famous DUAL-VANE design which provides and assures complete balance of all hydraulic pressure loads. These Pumps have capacities of 3, 5, 8 and 11 gpm at 1200 rpm.




## SERIES PF-100 DOUBLE PUMPS WITH VALVE PANELS

DUDCO PF-100 Series Double Pumps with Valve Panels are versatile units unmatched as a source of *Controlled Fluid Power* for a wide variety of modern industrial equipment . . . for 2000 psi operation of circuits calling for a substantial variation in pump volume as during "close and hold" or "traverse and feed" cycles. The Valve Panel contains the valving necessary for pressure regulation and flow control . . . the external part of a system will have less valves and controls, reduced piping and fewer parts to maintain. Ten capacity combinations with either automatic or remotely controlled operation.




## SERIES PV-600 PISTON-TYPE PUMPS

DUDCO PV-600 Series Variable Delivery Pumps generate continuous duty pressures up to 5000 psi. Two types of controls match pump output to system demands. A pressure-compensated regulator automatically varies the volume in response to system pressure. A hand wheel control enables an operator to vary the volume during the machine cycle. High pressure variable delivery means power is transmitted without the necessity for an accumulator and without any wastage of power thru a relief valve.

**WRITE TODAY . . .**

**Get full particulars on these important new developments in hydraulic pumps!**

The New York Air Brake Company
1112 East 222nd Street
Cleveland 17, Ohio

Please send details on

- ☐ SERIES PF-100 VANE-TYPE PUMPS
- ☐ SERIES H GEAR-TYPE PUMPS
- ☐ SERIES PF-100 DOUBLE PUMPS WITH VALVE PANELS
- ☐ SERIES PV-600 PISTON-TYPE PUMPS

Name_____

Address_____

City_____ Zone_____ State_____

# Are Your Fasteners HEADED FOR TROUBLE?

Screws are sometimes like people. If they "lose their heads" under pressure — if they turn out to be "softies" — if they don't "square up," they are *headed for trouble*. It takes only a few "bad" screws on the line each day to erase most planned assembly savings.

That is why quality standards for P-K Self-tapping Screws were set so *high* when they were first introduced by Parker-Kalon. Today, with even *higher standards* they continue to take top honors for dependability, despite many efforts to match them.

The difference between screws made to P-K standards and those that are "headed for trouble" are hard to see at a glance, but the effects of screw failure (parts spoilage, high reclamation costs) are quickly evident in mounting assembly costs.

P-K Self-tapping Screws are "headed for savings"—not only headed, but threaded, pointed, and heat-treated with the same purpose, to keep your assembly lines trouble-free. That's why so many more manufacturers of America's best known products specify P-K. For information on any fastening problem, talk to a P-K Assembly Engineer. Or write: Parker-Kalon Division, General American Transportation Corporation, 200 Varick St., New York 14.

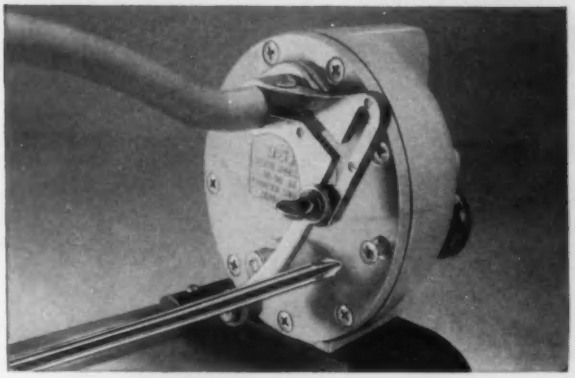
IS HEAD UNDERSIZE?
DO HEADS POP OFF?
IS HEAD ECCENTRIC?
IS SLOT BURRED?
IS SLOT TOO DEEP?
IS SLOT TOO SHALLOW?
IS SLOT OFF CENTER?
P-K STANDARDS make sure you get fasteners HEADED for SAVINGS

**P-K STANDARDS** protect you against these and many other symptoms of Screws "headed for trouble". They don't "get by" P-K inspectors — that's why *all* P-K Self-tapping Screws can be "Guaranteed First Quality."

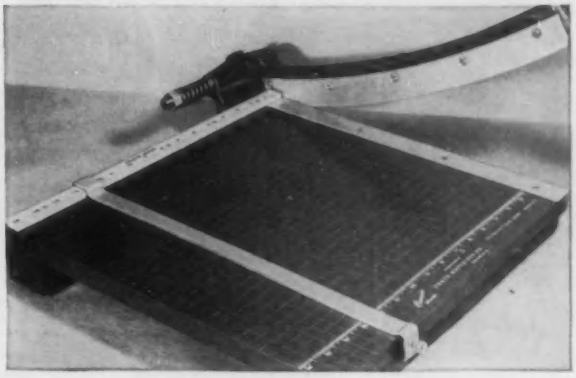
**PARKER-KALON®**

**IN STOCK** . . . see your nearby P-K Distributor . . .

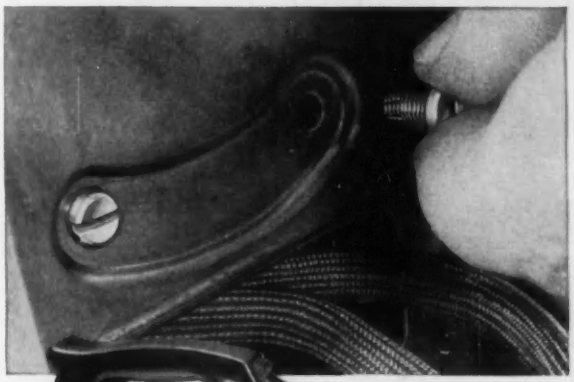
**"SWINGIN' SPRAY," MELNOR** Products Co.'s popular lawn sprinkler keeps on "swinging" because the oscillating mechanism is separate and sealed from the water intake system. To assure equally dependable assembly strength resistant to the roughest handling, Melnor fastens zinc and aluminum parts with P-K Screws, 7 Phillips Head Type Z and 18 Type F, driven with air tools.



**IN THE PREMIER CUTTING BOARD,** made by Photo Materials Co., when 21 P-K Type A replaced wood screws to fasten the ruler, straight blade, bearing casting, and bottom cleats to the hard maple board, pilot holes were eliminated. The 5 P-K Type F Screws that now fasten curved blade to cast iron handle ended tapping. Power driving further speeds assembly.



## with P-K quality—planned assembly savings pay off



**HOOVER SMOOTHED OUT** trouble and speeded assembly of this Steam or Dry Iron by switching to P-K Self-tapping Screws for seven fastenings previously made with machine screws. Tapping and lock washers were eliminated. The assembly is made stronger than ever, with an important saving in time. Five P-K Type F Screws fasten the phenol formaldehyde handle to the sole plate cover (left). On the assembly line, these screws are power driven. One P-K Type F Screw fastens the steam valve control support bracket to the die-cast aluminum filler tube at the front of the iron (not shown). One P-K Type A Screw fastens the heel closure plate to the terminal bracket (right).

*The Original*

# SELF-TAPPING SCREWS

**your local Supply and Service Specialist**

THIS MOTOR HAS INHERENT KLIXON OVERHEATING PROTECTION
PROTEGE PAR KLIXON CONTRE SURCHAUFFEMENT
GESICHERT MITTELS KLIXON GEGEN ÜBERHITZUNG
MUNITO DEL SALVAMOTORE KLIXON PROTEZIONE INTERNA TERMOSTATICA
MUNIDO DO KLIXON GUARDAMOTOR INTERNO TERMOSTATICO
PROTECCION INTERNA KLIXON CONTRA SOBRECALOR
THIS MOTOR HAS INHERENT KLIXON OVERHEATING PROTECTION
THIS MOTOR HAS INHERENT KLIXON OVERHEATING PROTECTION

# KLIXON Inherent PROTECTORS

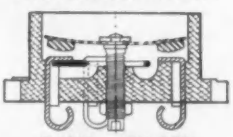
# *Used the World Over*

## For Dependable Overheat Motor Protection

North America, South America, Europe, Asia, Africa . . . wherever you go, you'll find electric motors equipped with Klixon Inherent Protectors. The reason — manufacturers, as well as users, of motors know that Klixon Inherent Protectors prevent motors from burning out . . . keep them running longer. They reduce repairs and maintenance, minimize production delays, permit the motor to operate safely at maximum capacity.

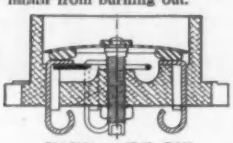
You, too, can benefit by using motors with Klixon Inherent Protectors.

### HERE'S HOW KLIXON PROTECTION WORKS



**CLICK! . . . IT'S OFF!**

Should a motor become overheated and dangerously hot, the Klixon Protector snaps the power "off" preventing the motor from burning out.



**CLICK! . . . IT'S ON!**

When the motor cools to safety, the Klixon Protector snaps the power "on" automatically, or by pushing the red button when the manual reset type is used.

MANUAL RESET

**KLIXON**

TRADE MARK REG. U. S. PAT. OFF.

AUTOMATIC RESET

**METALS & CONTROLS CORPORATION**
**SPENCER THERMOSTAT DIVISION**
**908 FOREST STREET, ATTLEBORO, MASS.**

**PROBLEM: Reduce manufacturing costs and waste in fabrication of electrical contact Spring Clips**

**SOLUTION: General Plate provided the solution with long continuous length coils of coin silver clad to phosphor bronze . . . a Composite Metal**

A manufacturer of television tuners required a contact material for use in the fabrication of narrow and thin contact spring clips. Extremely close tolerances and long continuous lengths were prerequisites.

The problem was presented to General Plate who quickly found the solution with coin silver clad to phosphor bronze and provided the material in coils up to 20 inches diameter of a single continuous length. This saved the manufacturer many dollars by eliminating idle machine time and reducing waste practically to zero. The coin silver gave a non-porous, long wearing contact surface — the phosphor bronze excellent spring qualities.

You, too, can benefit with General Plate raw stock contact materials. They are available in various combinations, single or double inlay, overlay, single or double edgelay and Top-Lay. General Plate Composite Contact Materials will save you money and enable you to make contact assemblies superior to those produced by other methods.

In addition to raw stock, General Plate fabricates contacts and complete contact assemblies. By letting General Plate fabricate your complete contact assemblies, you will save money, time and trouble . . . needless equipment cost and problems of scrap disposal are eliminated . . . contacts and/or contact assemblies made to your exact specifications are shipped to you ready for installation.

The long experience, diverse facilities and manufacturing skill of General Plate will benefit you in the form of service, quality and savings.

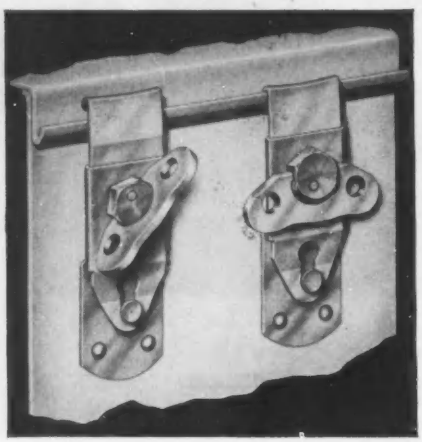
Write for complete information and Catalog PR700.

*You can profit by using*
*General Plate Composite Metals*

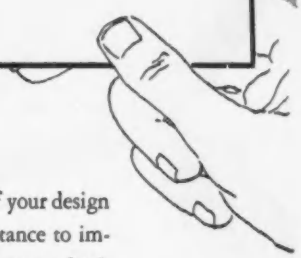
**METALS & CONTROLS CORPORATION**
**GENERAL PLATE DIVISION**
**18 FOREST STREET, ATTLEBORO, MASS.**

# Have you a similar fastening problem?

**File: Simmons LINK-LOCK**



**When the armed forces** needed a positive, high-strength fastening device for instrument housings, transit cases, and storage boxes, Simmons developed LINK-LOCK. This *brand-new* device doesn't use springs, yet works with fingertip pressure through a unique mechanical arrangement: the vertical sliding latch is moved in and out of locking position by a disc rotated with a wing nut. The fastener is immune to low temperatures, is easy to operate even with arctic mittens, furnishes up to 450-lb. pull-down pressure. Open or closed, it lies flat against the side of the case it fastens.



**LINK-LOCK may be the answer** to your fastening problem. If your design involves heavy fastening pressures, watertight sealing, high strength, resistance to impact, ask about LINK-LOCK. Simmons can furnish it with special engagement-latch details, or for operation by bolt or screwhead instead of wing nut. Write for LINK-LOCK DATA SHEET today. It gives complete details and dimensions. A Simmons engineer will be glad to work with you on your fastening problems.

SIMMONS FASTENER CORPORATION, 1751 No. Broadway, Albany 1, New York

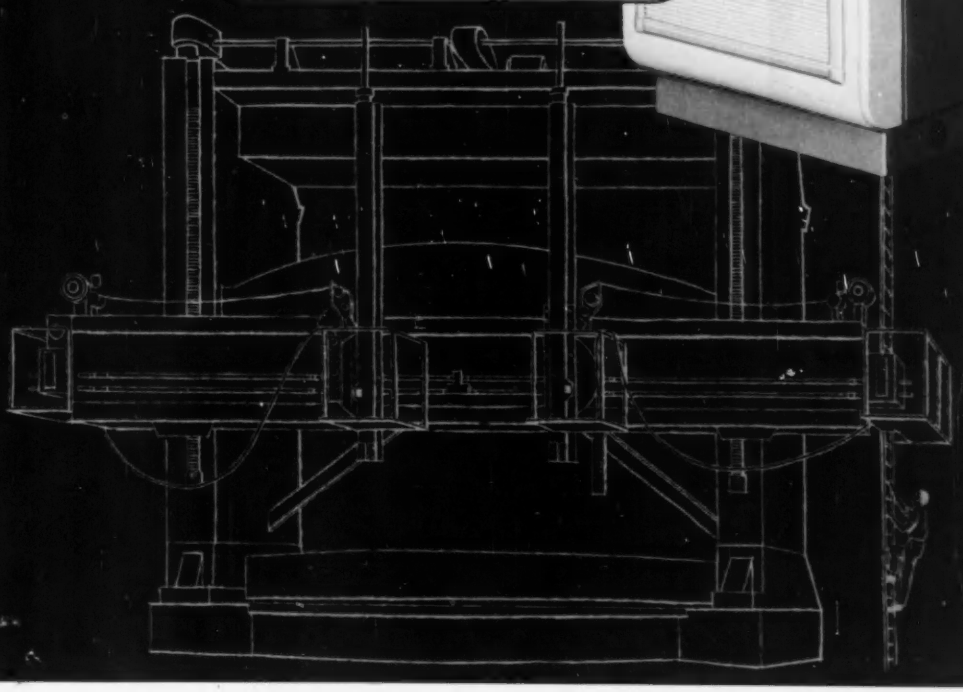
Simmons QUICK-LOCK SPRING-LOCK ROTO-LOCK LINK-LOCK DUAL-LOCK

JUST OUT! NEW 36-PAGE CATALOG WITH APPLICATIONS. SEND FOR IT!

# HERE'S ADVANCED-DESIGN SPEED CONTROL

# New

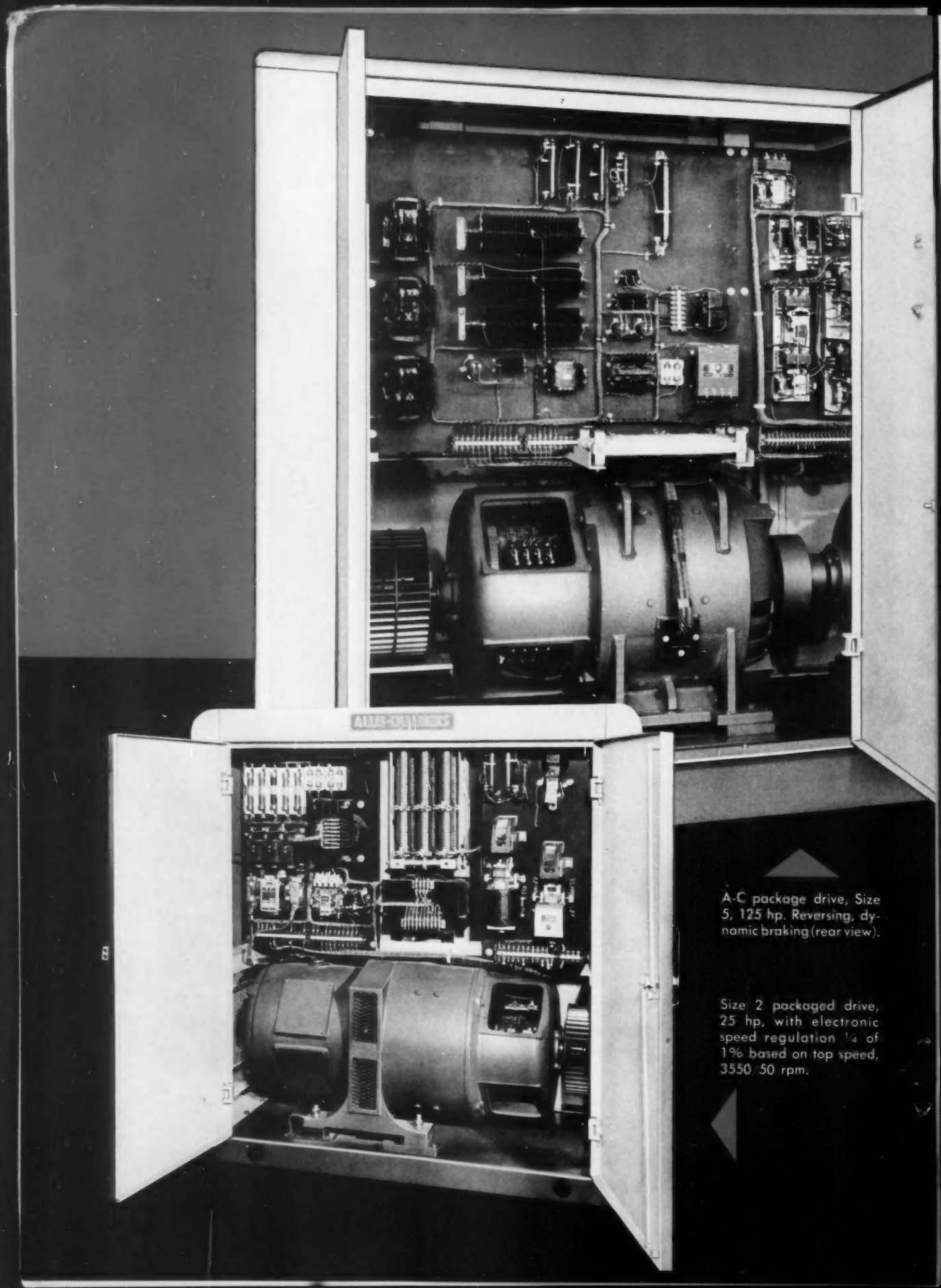
## ALLIS-CHALMERS PACKAGE DRIVES



This compact, attractive Size 2 cabinet houses a 25-hp package drive. Package drives like this are widely used for machine tools such as vertical boring mills.

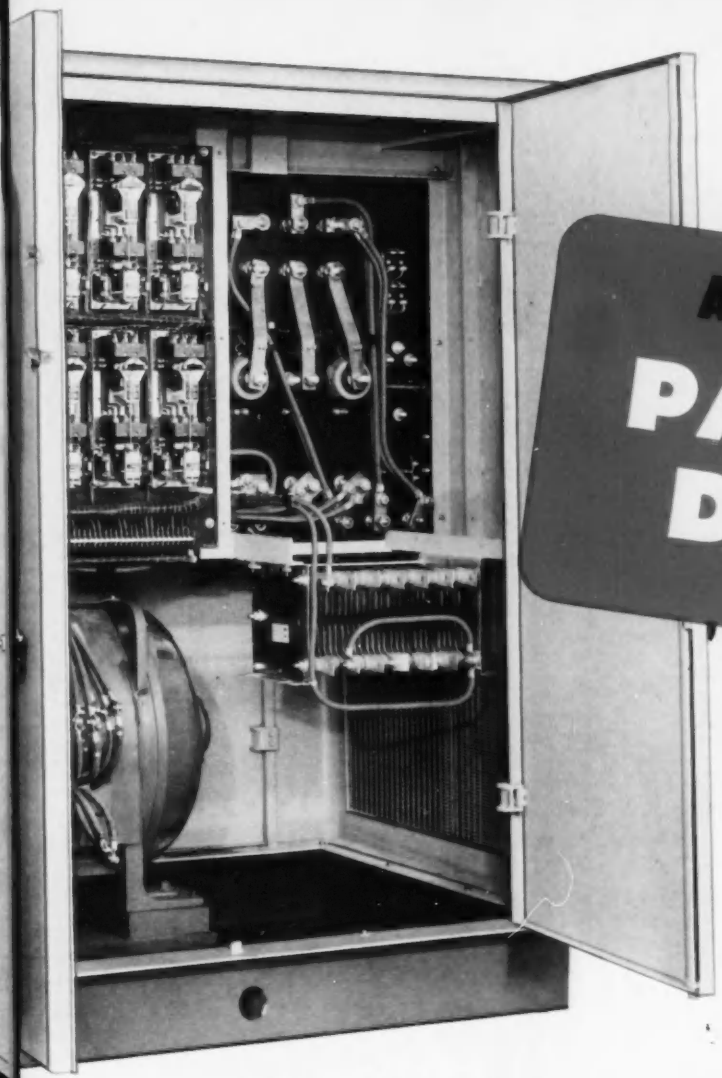
A-24412

# ALLIS-CHALMERS



A-C package drive, Size 5, 125 hp. Reversing, dynamic braking (rear view).

Size 2 packaged drive, 25 hp, with electronic speed regulation ¼ of 1% based on top speed, 3550 50 rpm.



# ALLIS-CHALMERS PACKAGE DRIVES

*For* speed control of machine tools and other applications requiring accurately variable speed over a wide range

## Get ALL of these advanced features

- Magnetic amplifier generator field control.
- All machine functions controlled from one or more remote points.
- Potentiometer rheostat in control station (optional).
- Control may be preset for repetitive operations.
- Full protection against overload, undervoltage. Other protective devices to suit the application.
- Complete group of optional features including:
  - — dynamic or regenerative braking
  - — reversing
  - — jogging
  - — controlled rate of acceleration and deceleration

**GET COMPLETE DETAILS** on the Allis-Chalmers Package Drive to fit your particular application. Available in 5 cabinet sizes — 5 to 150 hp. Call your nearby Allis-Chalmers Office or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Package Drive Bulletin 51B8166.

# ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Milwaukee 1, Wisconsin

# Everything You Need...
# *from Power Line to Driven Shaft*

### Motor, Control, *Texrope* V-belt Drive ... All from one reliable source

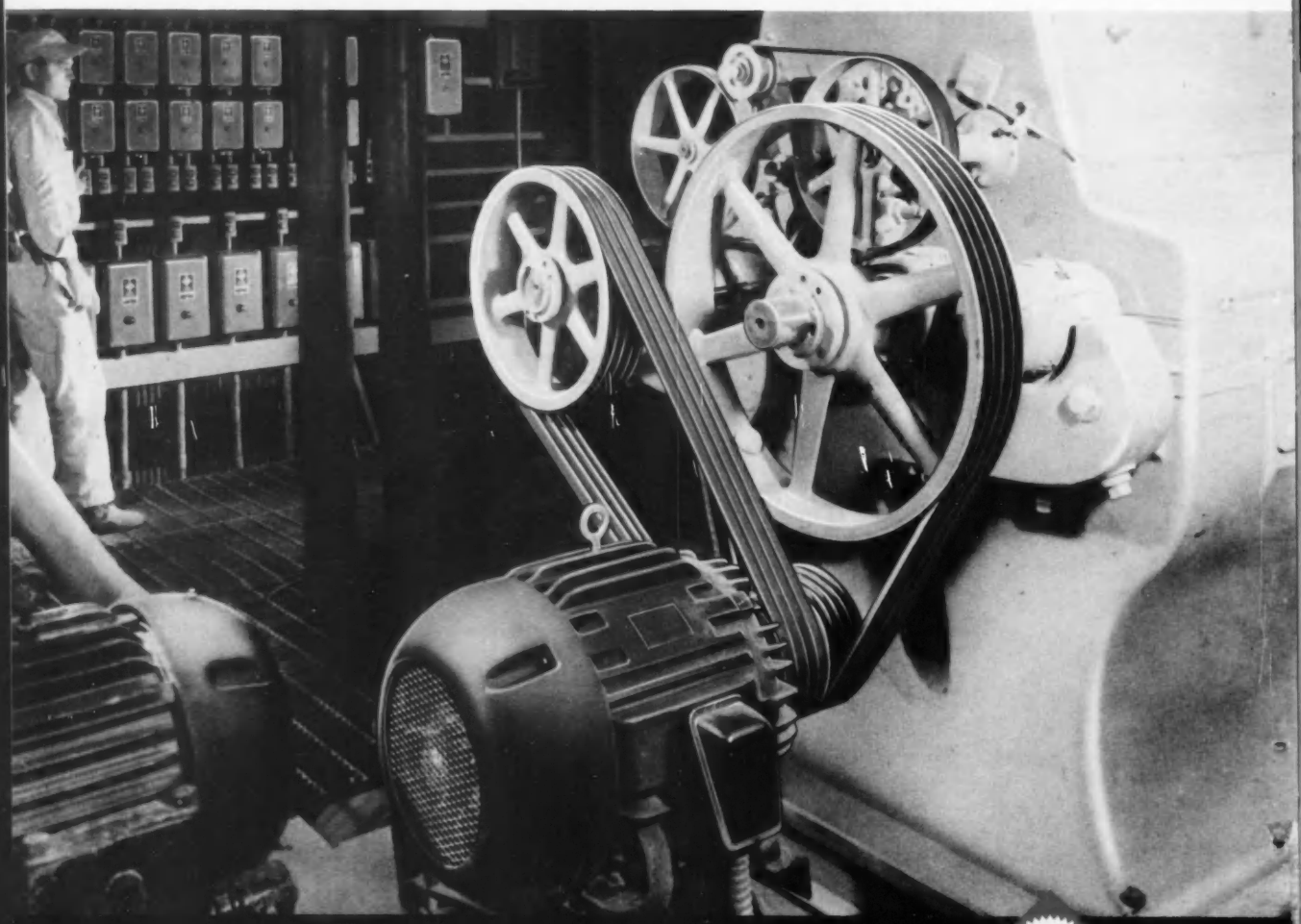
You will save time and engineering costs and reduce assembly problems when you use an Allis-Chalmers complete machine drive. Components are of coordinated design and manufacture. Ratings coincide and parts fit and work together properly when assembled. One requisition, one order, one invoice saves on paperwork. And you can obtain engineering assistance from qualified field application engineers who thoroughly understand the complete drive problem.

### NATION-WIDE CERTIFIED SERVICE

Almost a hundred Allis-Chalmers Certified Service Shops in industrial areas in all parts of the country provide factory-approved service and parts. If you use a special motor, Certified Service Shops have the full benefit of factory drawings and advice for service work.

Call the Allis-Chalmers District Office near you next time you have a drive problem. A competent application engineer will be glad to put the full facilities of Allis-Chalmers at your disposal.

*Texrope* is an Allis-Chalmers trademark

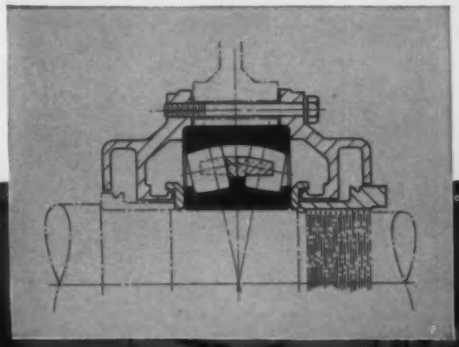


# ALLIS-CHALMERS

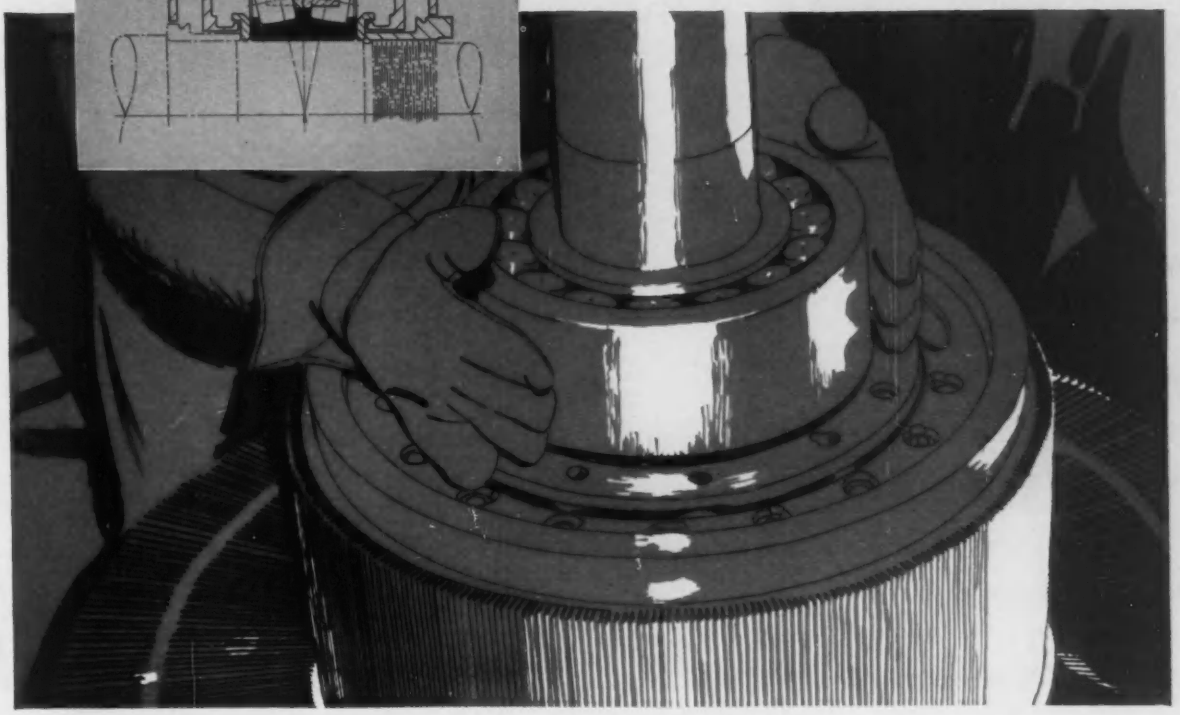
A-C ALLIS CHALMERS

Milwaukee 1, Wisconsin

TORRINGTON BEARINGS AT WORK



*Precision-ground TORRINGTON Spherical Roller Bearings help cut friction on shaft of a General Electric direct current generator.*



## Cutting friction and costs throughout industry!

Name your toughest, costliest bearing problem, TORRINGTON Bearings will solve it—just as they have solved scores of such problems in virtually every major industry.

Consider, for example, TORRINGTON Spherical Roller Bearings—and these big advantages.

*Precision-ground contact surfaces*—for even load distribution, maximum bearing life. *Accurate geometrical conformity between races and rollers*—for ultimate load carrying capacity. *Carefully heat-treated races and rollers*—for maximum resistance to shock and wear. *Bronze, machined cage for each path of rollers*—for freedom of operation. *Integral center flange on inner race*—for positive radial stability and positioning for thrust loads. And self-alignment—for smooth service under shock loads at maximum speeds.

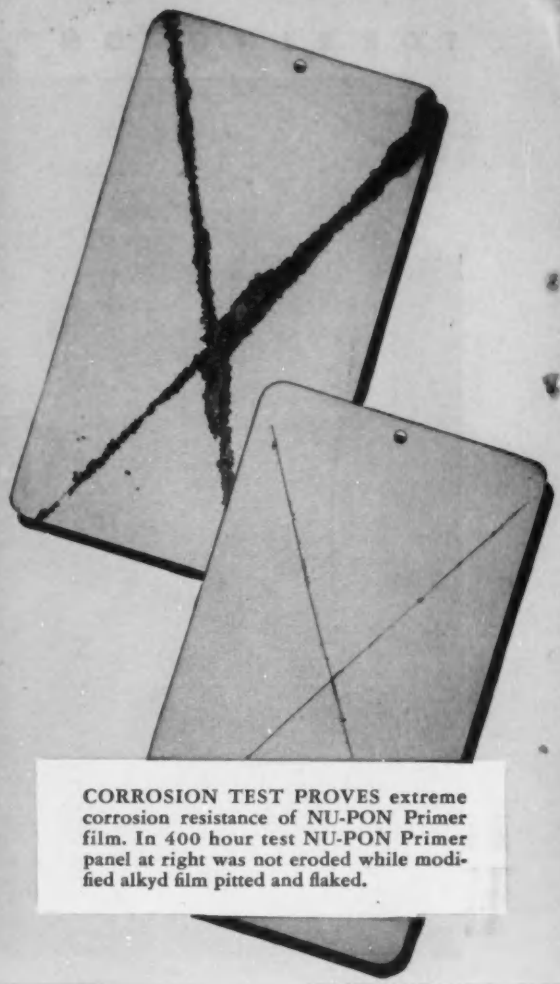
TORRINGTON Spherical Roller Bearings are available from stock with either straight or tapered bore for shaft or adapter mountings. Prove to yourself that it pays to buy the finest—specify TORRINGTON.

THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.

**TORRINGTON SPHERICAL ROLLER BEARINGS**

**Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers**

COLOR STYLISTS at the Glidden Color Studios will prescribe colors for your unit which harmonize with all that's new in floor covers, fabrics, and wall colors, to give your product maximum sales appeal.



CORROSION TEST PROVES extreme corrosion resistance of NU-PON Primer film. In 400 hour test NU-PON Primer panel at right was not eroded while modified alkyd film pitted and flaked.

# CORRECT COLOR ON THE OUTSIDE ...CORROSION RESISTANCE INSIDE

## AIR CONDITIONERS made more salable, more durable by two Glidden Services

Glidden offers you valuable assistance on two key problems in the finishing and styling of your air conditioners.

*First,* Glidden can supply you with the ideal finish for unit interiors—moisture resistant, corrosion resistant NU-PON Primer. This new coating is ideally suited for application by flow-coating or dipping. Result: maximum protective coverage and economy.

*Second,* The Glidden Color Studios offer you custom color styling that adapts your unit to today's decorating trends and enhances product design. These specialists, who developed the famous SPRED SATIN Dramatone color system for home decorating, have color styled a wide variety of products for leading manufacturers.

*Write today* for your copy of the informative booklet on Glidden NU-PON finishes.

**THE GLIDDEN COMPANY**

**INDUSTRIAL FINISHES DIVISION**

**11005 Madison Avenue • Cleveland 2, Ohio**

SALES OFFICES AND FACTORIES:

San Francisco, Los Angeles, Chicago (Nubian Division—1855 North Leclaire Avenue), Minneapolis, New Orleans, St. Louis, Cleveland, Reading, Atlanta. Canada: Toronto and Montreal.

*Quality of lightweight magnesium plate is strictly controlled.*

# a new look at Magnesium!

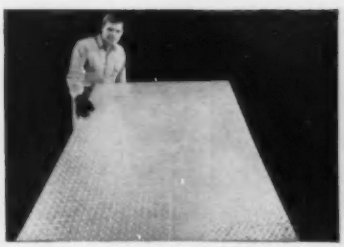
## PLATE IN LARGE SIZES AT LOW PRICES

The good news on magnesium plate is Dow's increased capacity—new facilities which are now making longer and wider sizes available at reduced prices.

Also coming in for considerable attention are the important design and fabrication economies made possible by this lightweight metal in large sizes.

For more information on magnesium, call the nearest Dow sales office or write direct to the Magnesium Sales Department of THE DOW CHEMICAL COMPANY, Midland, Michigan.

***Lightweight,** low cost magnesium tooling plate for more practical jigs and fixtures.*



*Light, safe, strong, low cost magnesium tread plate in the famous Inland 4-WAY design.*

*World's first 84-inch magnesium coil mill now rolls sheet and plate to greater lengths and widths.*

*Lightweight magnesium extrusions are available in many different sizes and shapes.*

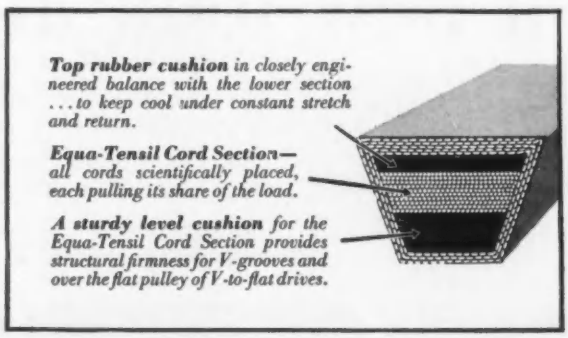
***you can depend on DOW MAGNESIUM***

DOW

# Handles MORE Horsepower... the new U. S. ROYAL SUPER-SERVICE BELT

Meet the *toughest* V-belt in the "U. S." Line. Delivering 40% more horsepower than standard belts, it also absorbs greater shock loads. Ideal where space is limited or where you want to decrease the number of belts required in order to use stock sheaves.

U.S. Royal® Super-Service is a "natural" for troublesome drives, especially heavy shock-load drives. High tensile strength, minimum stretch. All standard multiple sizes. Order from your distributor, or call any of United States Rubber Company's 25 District Sales Offices or write to address below.


***Top rubber cushion*** *in closely engineered balance with the lower section . . . to keep cool under constant stretch and return.*
***Equa-Tensil Cord Section***— *all cords scientifically placed, each pulling its share of the load.*
***A sturdy level cushion*** *for the Equa-Tensil Cord Section provides structural firmness for V-grooves and over the flat pulley of V-to-flat drives.*

**A COMPLETE DRIVE SERVICE**

MULTIPLE V-BELTS • F. H. P. V-BELTS • SHEAVES
FLAT BELTS AND BELTING • SPECIAL PURPOSE BELTS

*"U. S." Research perfects it.*
*"U. S." Production builds it.*
*U. S. Industry depends on it.*

US RUBBER

**UNITED STATES RUBBER COMPANY**
**MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.**

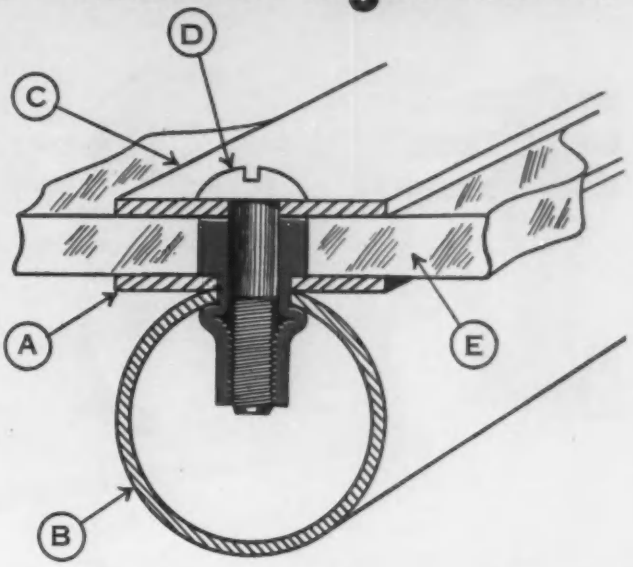
Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes
Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

# B. F. Goodrich RIVNUTS fasten plastic to tubular post, make weather-tight seal!

TO PROVIDE a neat, tight seal for airplane windows, designers needed a simple, one-piece fastener—a blind rivet and nut plate combined. They found the ideal answer in a spacer-head B. F. Goodrich Rivnut.

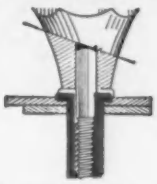
With the easy-to-use heading tool, one man quickly upset the Rivnut, securely riveted plate "A" to tubular center post "B". The firm bulge formed in the Rivnut shank conformed to the curvature of the tube. The Rivnut head served as a spacer for transparent plastic sheets "E". Screw "D" was then threaded into the clean, still-intact Rivnut threads to hold clamp strip "C" and plastic sheets in place.

Besides providing a tight, dependable seal, Rivnuts saved many man-hours on this job. If you're looking for a fastener which can improve your product and cut production time, why not get the facts from a Rivnut engineer? Write The B. F. Goodrich Company, Department PE-84, Akron, Ohio.

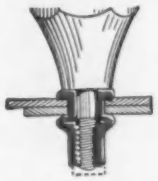



## *Rivnuts provide at least 6 clean threads in one simple operation!*

**1** Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



**2** Rivnut is inserted—head firmly against work—tool at right angles to work.

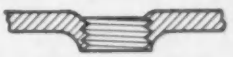


**3** Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

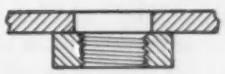
**4** After upset, Rivnut threads are still clean and intact, ready for screw attachment.

## *Compare these 4 methods of putting screw threads in thin sheet metal*

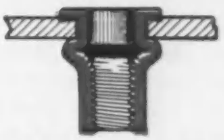
Tapped—2 threads



Pierced and tapped—3 threads



Projection welded—4 threads



Rivnut—at least 6 threads

**B.F.Goodrich**

# RIVNUTS

*The only one-piece blind rivet with threads*

**SEND NOW FOR FREE RIVNUT DEMONSTRATOR**

Shows with motion how Rivnuts work. Explains construction, gives proved applications. Write to The B. F. Goodrich Co., Dept. PE-84, Akron, Ohio.

# Look what you can do with Alcoa® Aluminum on your six-spindle Conomatics

Conomatics are the only multiple bar automatics built with short, "weaveproof" upright frame members secured between a large, heavy top bed and base. Such construction makes possible a strong bridged support for the tooling area and its "work and tool axis."

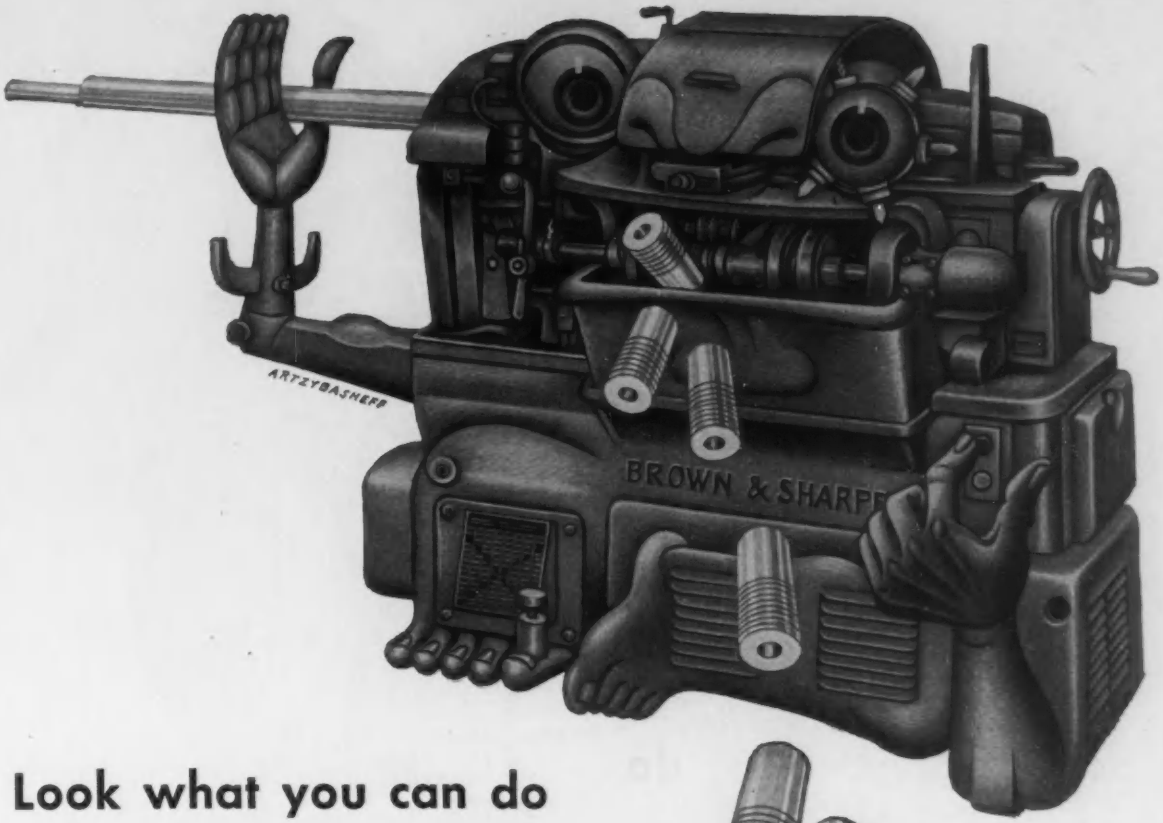
With such a strong and sturdy frame, you can really "horse" Alcoa Aluminum Bar Stock through your Conomatics. Finished parts are smooth, with dimensional tolerances held to consistently close limits. Piece costs are lower, since from a pound of aluminum you can get three times as many parts as from a pound of the heavier metals. What's more, aluminum parts won't rust or corrode and are exceptionally good conductors of electricity and heat.

Find out more about Alcoa Aluminum Screw Machine Stock—today. Contact your local Alcoa sales engineer or Alcoa distributor. Both are listed under "Aluminum" in the classified section of your telephone directory. Or write, ALUMINUM COMPANY OF AMERICA, 853-H Alcoa Building, Pittsburgh 19, Penna.

**PRODUCTION AND DESIGN ENGINEERS will want two Alcoa booklets, *Alcoa Aluminum in Automatic Screw Machines* and *Corrected Tool Diameter Tables*. Also available at no extra cost are two precision computers —a Speed-Feed calculator, and an alloy property guide which shows at a glance the various properties of Alcoa Aluminum Screw Machine Stock.**

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

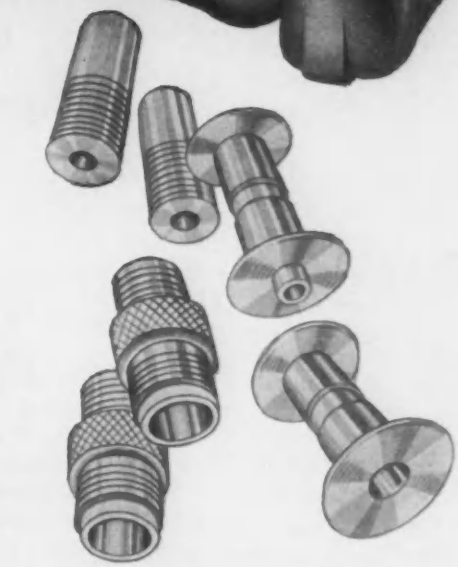



# Look what you can do with Alcoa® Aluminum on your Brown & Sharpe automatics

196 two-speed combinations provide the spindle on No. 2G Brown & Sharpe automatic screw machines a wide selection of ratios. These make possible the use of proper threading speeds with no limitation on top speeds for forming, drilling and similar operations.

What's more, with Alcoa Aluminum Screw Machine Stock, you can utilize maximum spindle speeds, which, for a No. 2G having a one-inch capacity spindle, is 3025 rpm. Finishes are smooth with tolerances consistently uniform. Piece costs are lower, since from a pound of aluminum you can get three times as many parts as from a pound of the heavier metals. Aluminum parts are excellent conductors of electricity and heat, and are highly resistant to rust and corrosion.

Find out now what Alcoa Aluminum Screw Machine Stock can do for your products. Contact your local Alcoa sales engineer or Alcoa distributor, both listed under "Aluminum" in the classified section of your telephone directory. Or write, ALUMINUM COMPANY OF AMERICA, 853-H Alcoa Building, Pittsburgh 19, Pa.

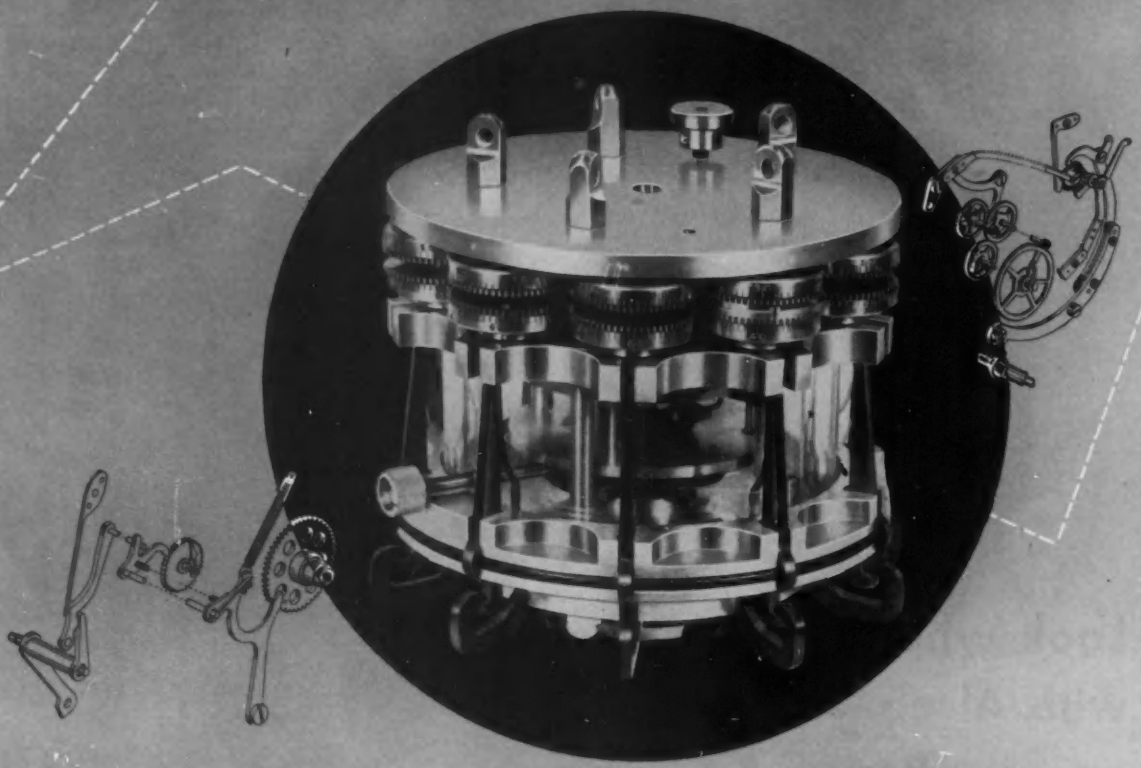


**PRODUCTION AND DESIGN ENGINEERS will want two Alcoa booklets, *Alcoa Aluminum in Automatic Screw Machines* and *Corrected Tool Diameter Tables*. Also available at no extra cost are two precision computers —a Speed-Feed calculator, and an alloy property guide which shows at a glance the various properties of Alcoa Aluminum Screw Machine Stock.**

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

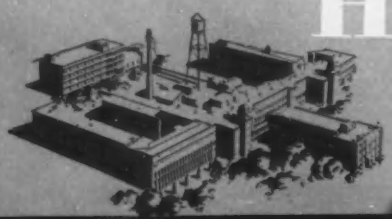
# *how to make a good product*



## *with the help of Hamilton's COMPLETE Precision Production Facilities*

Developing a new product? Planning to improve an existing one? When your problem involves a complex mechanism, like the ones shown above, or precision components—the complete production facilities that make America's finest watches and produce vital defense material —are available to help solve your problems.

You are invited to investigate this *complete* source for screws, springs, flat and recessed shapes, jewel bearings, investment castings, pinions, wheels, assemblies, or any other "problem parts" to help improve *your* products. Send us your prints . . . of course, there's no obligation.

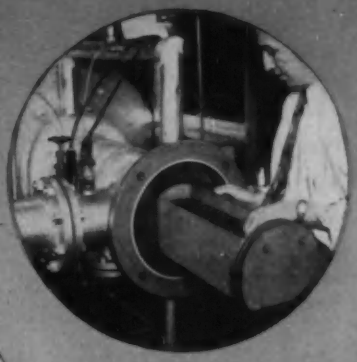


**Allied Products Division**

**Hamilton Watch COMPANY**

922 WHEATLAND AVE., LANCASTER, PA.

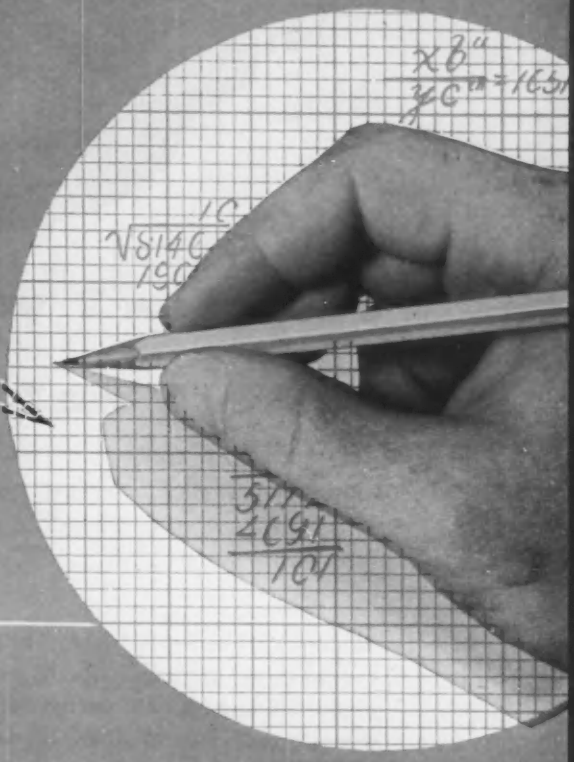
# *better!*



*heat treating*

*fabrication*

*assembly*



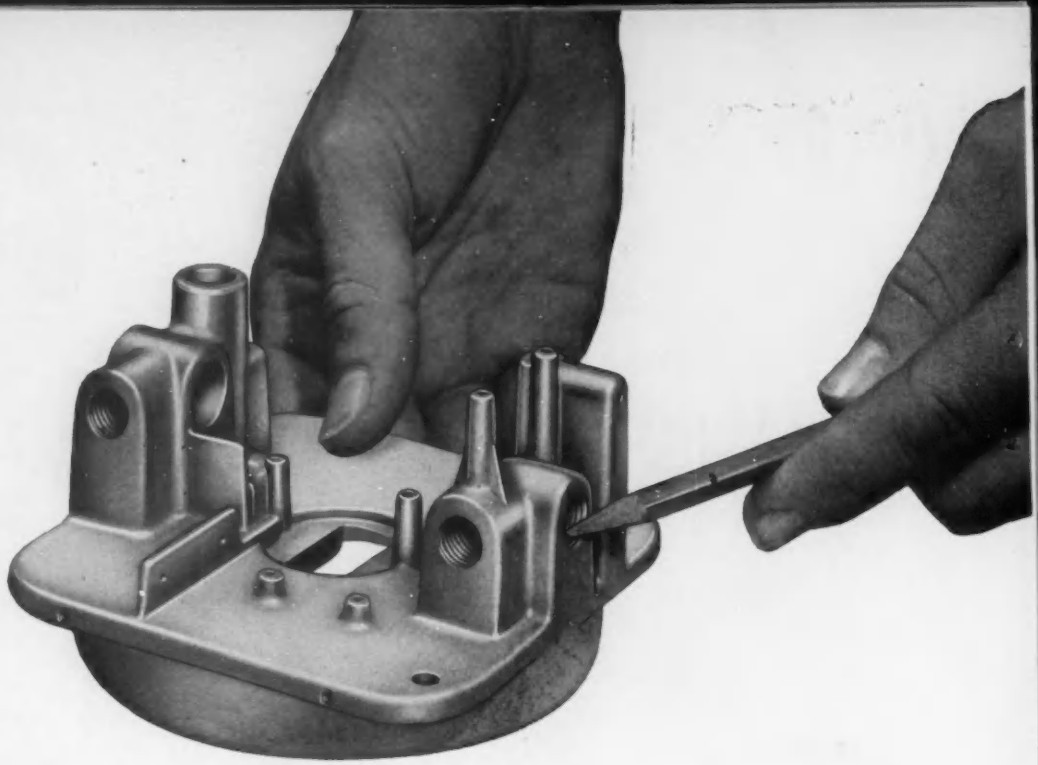
*gauging and inspection*

*backed by*

*engineering*

*metallurgy*

*physical & chemical testing*



# complex? yes . . .

# costly? no!

● Resourcefulness, plus complete machining facilities, enabled **Stewart** to produce this unusual die casting in volume—economically!

This one kept us awake nights. The job called for an internally cast jar thread and a great deal of precision machining. To speed production and cut costs, we devised a setup that performed 24 separate machining operations *at one time*. Whatever type of die castings you need – small or large, simple or intricate – count on *Stewart* to meet your most rigid specifications . . . on time.

**SERVICES AVAILABLE . . .** **Designing • Engineering • Die Making Metallurgical Control • Most Modern Die Casting Equipment • Complete Machining, Polishing and Assembly Facilities.**

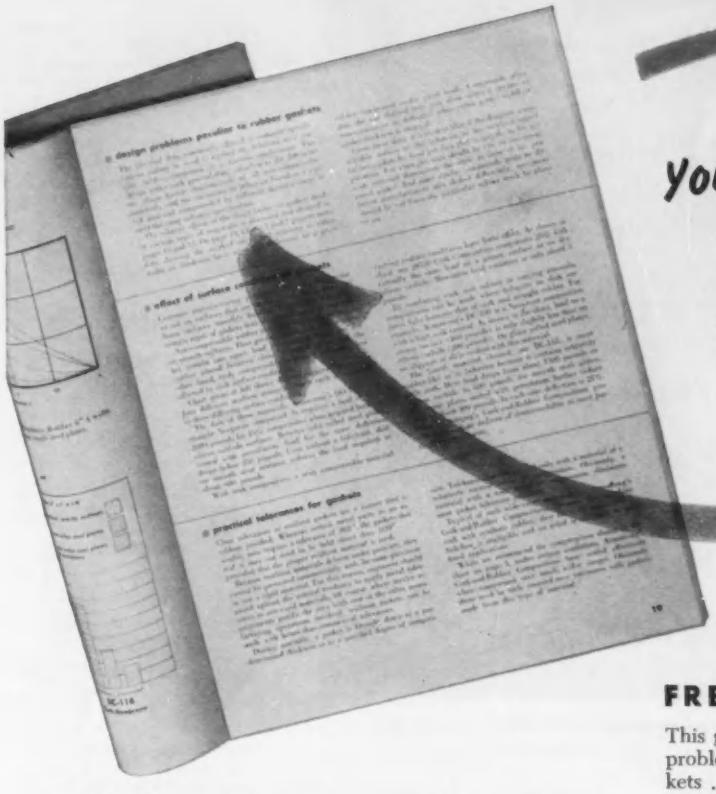
*44 years of helping industry to "Make It Better"*

Stewart **DIE CASTING**

. . . a division of STEWART SW WARNER

CHICAGO, ILLINOIS, 4535 FULLERTON AVENUE • BRIDGEPORT, CONNECTICUT, 275 WARREN STREET

# Why do rubber gaskets present special problems to designers?



*You'll find the answer in this newly revised gasket manual*

## *17 helpful sections, including:*

- **Designing flanges for efficient sealing**
- **Sealing with confined resilient gaskets**
- **Designing gaskets to reduce costs**
- **Effect of gasket width on compression**
- **Relation of gasket thickness to load**
- **Design problems peculiar to rubber gaskets**
- **Effect of surface conditions on gaskets**

## FREE FOR YOUR FILES

This gasket manual helps you solve special design problems posed by non-compressible rubber gaskets . . . has practical data on tolerances for various gasket materials . . . gives data on materials that meet current SAE-ASTM and U. S. Government specifications. "Armstrong's Gasket Materials" is a helpful 24-page manual for those who design and use gaskets. Gives information on gasket materials, gives suggestions on gasket, flange, and joint design, plus what to look for when choosing a material. In Sweet's product design file, section 3h, or send coupon below for a personal copy.

**SEND COUPON TODAY**

Armstrong Cork Co., Industrial Div.,
7108 Irvin St., Lancaster, Pennsylvania

Please send me your new 24-page gasket manual.

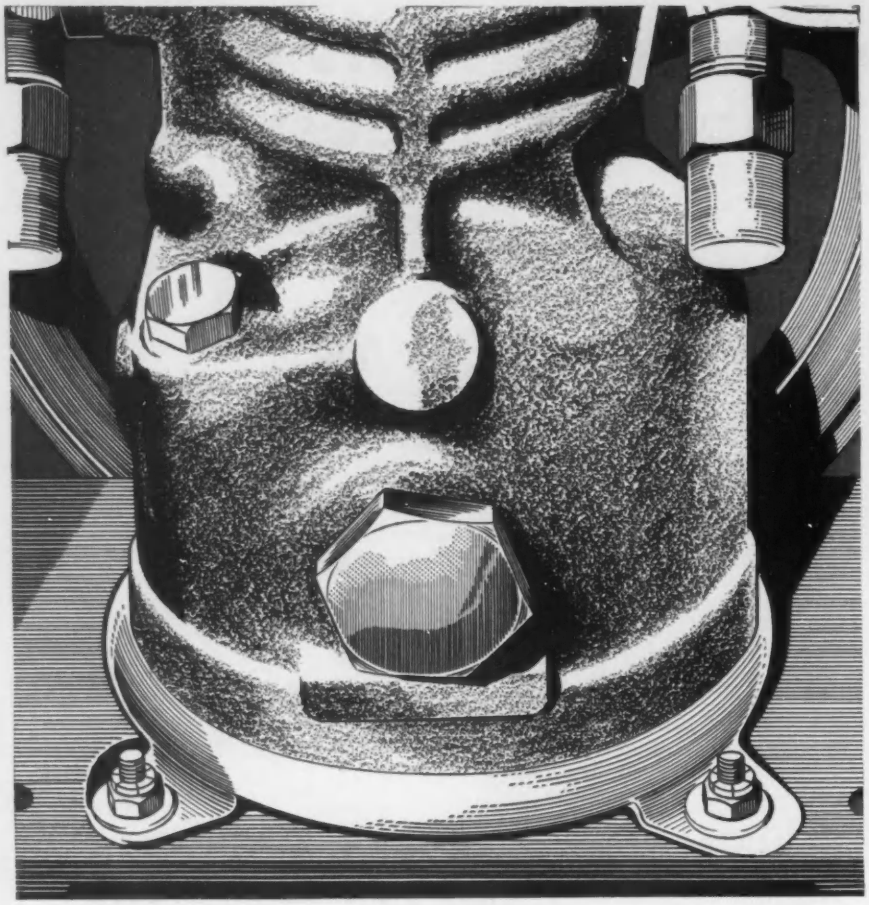
*Name* _____

*Company* _____

*Address* _____

_____ *Position* _____

# ARMSTRONG'S GASKET MATERIALS

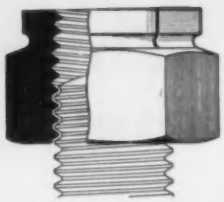


**Many manufacturers use FLEXLOCs** to fasten motors, compressors and other vibrating equipment to mounting plates. FLEXLOCs won't work loose . . . they eliminate costly service calls.

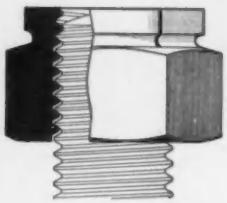
# FLEXLOC locknuts reduce costly service calls

FLEXLOC locknuts do this because they stay put anywhere on a bolt as soon as their locking threads are fully engaged. Even the most severe vibration will not work them loose. FLEXLOCs offer many other advantages, too. *They are one piece.* They eliminate complicated, time-consuming methods of locking studs and bolts. They provide simpler, faster application and safer, more dependable locking than plain nuts and lockwashers, castellated nuts and cotter pins, nuts and jam nuts. They save buying, stocking and handling of extra parts. *They are all metal.* They have higher tensile strength than most other lock nuts. They permit you to stock only one nut for all temperatures to 550°F. *They are reusable.* They can be applied again and again without losing locking efficiency—a plus value in maintenance.

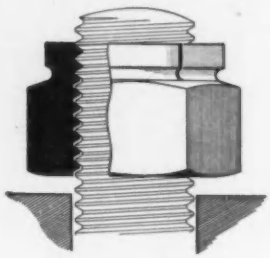
For information about FLEXLOCs and samples for test purposes, see your FLEXLOC distributor or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.



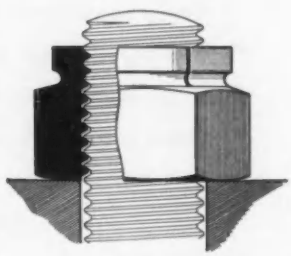
**Starting.** A FLEXLOC starts like any ordinary nut. Put it on with your fingers. Tighten it with a standard hand or speed wrench.



**Beginning to Lock.** As the bolt enters the segmented locking section, the section is expanded, and the nut starts to lock.



**Fully Locked As a Stop Nut.** When 1½ threads of a standard bolt are past the top of the nut, the FLEXLOC is fully locked. A FLEXLOC does not have to seat to lock.



**Fully Locked As a Seated Nut.** When it is used as a lock or stop nut, the locking threads of the FLEXLOC press inward against the bolt, lifting the nut upward and causing the remaining threads to bear against the lower surface of the bolt threads. Vibration will not loosen a FLEXLOC, yet there is no galling of threads.

**FLEXLOC®** LOCKNUT DIVISION

**SPS** JENKINTOWN PENNSYLVANIA

OIL RESISTANCE

WEATHER RESISTANCE

FLEXIBILITY

# These properties of neoprene make a better OUTBOARD MOTOR

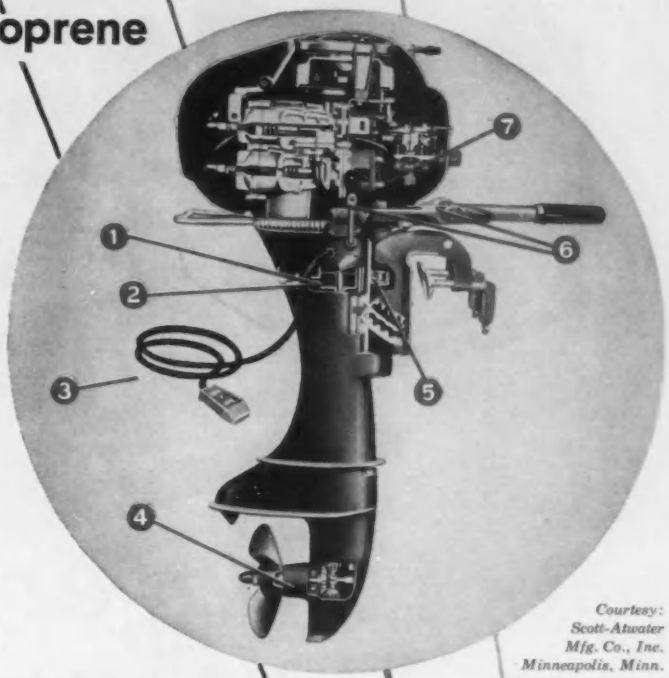
Smart streamlining distinguishes this new '54 outboard—and there's ample evidence of the designers' attention to mechanical detail as well. For no less than 7 parts are made with Du Pont neoprene to improve performance and reduce the need for maintenance.

An outstanding feature of this motor is an automatic bailing device—linked from an immersion unit to the motor by durable neoprene hose which can withstand the effects of seasons of direct sunlight and weathering without cracking. The bailing pump itself makes use of neoprene in a unique rotor which can withstand constant abrasion.

Neoprene is also employed for the carburetor line because gasoline has little effect on it. And in the propeller hub, shock-absorbent neoprene gives lasting protection even in salt water.

Finally, the entire motor is suspended in a resilient neoprene cushion to reduce noise and vibration. With *all* these features provided by *one* resilient material, it's small wonder that today more designers are turning to neoprene than ever before.

1. Bailing pump rotor
2. Cooling pump rotor
3. Bilge Hose
4. Shock-absorbent hub
5. Motor cushion
6. Remote control cables (not shown)
7. Carburetor drain line




*Courtesy: Scott-Atwater Mfg. Co., Inc. Minneapolis, Minn.*

**PROPERLY COMPOUNDED NEOPRENE WILL RESIST:**

**NEOPRENE**

***The rubber made by Du Pont since 1932***

DU PONT

REG. U. S. PAT. OFF.

**BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY***

***FREE!* THE NEOPRENE NOTEBOOK**

Each issue shows new, unusual applications of neoprene . . . new products . . . improved designs. Add your name to the mailing list today.

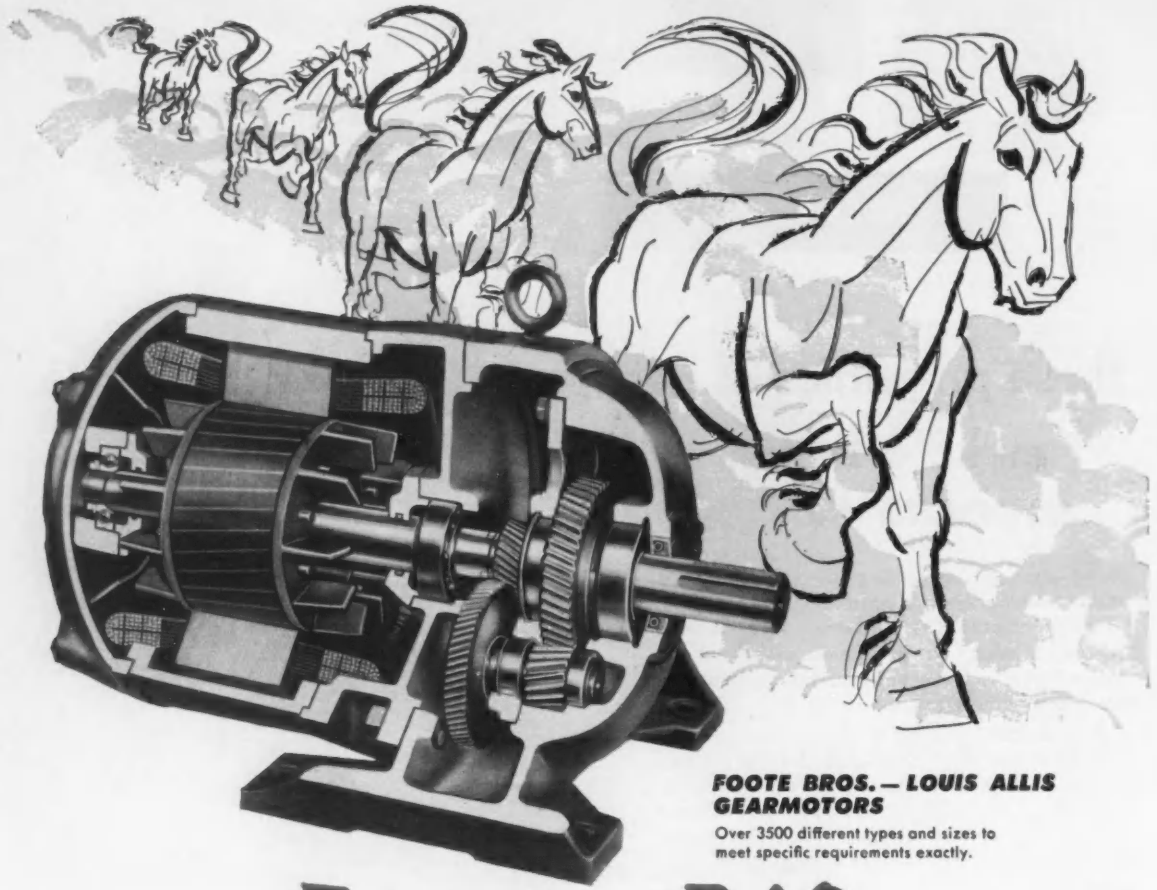
E. I. du Pont de Nemours & Co. (Inc.)
Rubber Chemicals Division PE-8, Wilmington 98, Del.

*Name*_____ *Position*_____

*Firm*_____

*Address*_____

*City*_____ *State*_____



**FOOTE BROS.—LOUIS ALLIS GEARMOTORS**

Over 3500 different types and sizes to meet specific requirements exactly.

# *Longer Life*

## *with Less Maintenance*

FOOTE BROS. Duti-Rated LIFETIME GEARING

FOOTE BROS.

*Better Power Transmission Through Better Gears*

*Manufacturers of industrial gears and enclosed gear drives of all kinds, gearmotors, aircraft-quality gears, actuators and special machinery.*

### *Write for complete details...*

Get all the facts and figures on how Foote Bros. drives with Duti-Rated Lifetime Gears can fit into your production picture. Write today . . . or see your local Foote Bros. representative now!

**WITH FOOTE BROS.**

### *Duti-Rated* LIFETIME GEARS

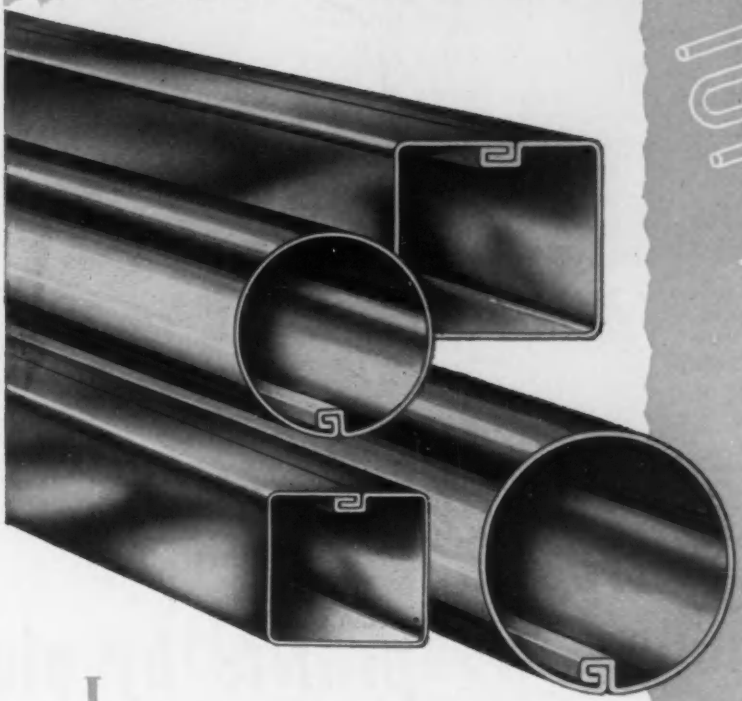
*Now* when you install an enclosed gear drive with Duti-Rated Lifetime Gears, you *know* it will give you the longer, trouble-free performance you're looking for! And for your applications, Foote Bros. offers you 2 different drives . . . famous Foote Bros.—Louis Allis Gearmotors and proven Foote Bros. Line-O-Power Drives. Both incorporate the world's finest industrial gearing, Duti-Rated Gears . . . a unique and revolutionary development by Foote Bros. that offers super-hard precision gears with much longer life and higher capacity than ordinary industrial gears . . . in much less space. For performance you can measure, quality you can trust—always insist on dependable Foote Bros. drives with longer-lasting Duti-Rated Lifetime Gears!

**LINE-O-POWER DRIVES**

Feature space saving, longer life Duti-Rated Lifetime Gears. Available in double and triple reductions with ratios from 5 to 1, up to 238 to 1; capacities range up to 200 h.p.

FOOTE BROS. GEAR AND MACHINE CORPORATION • 4545 SOUTH WESTERN BOULEVARD • DEPT. W • CHICAGO 9, ILLINOIS

# Roll Formed Tubing answers design, production and cost problems . . .



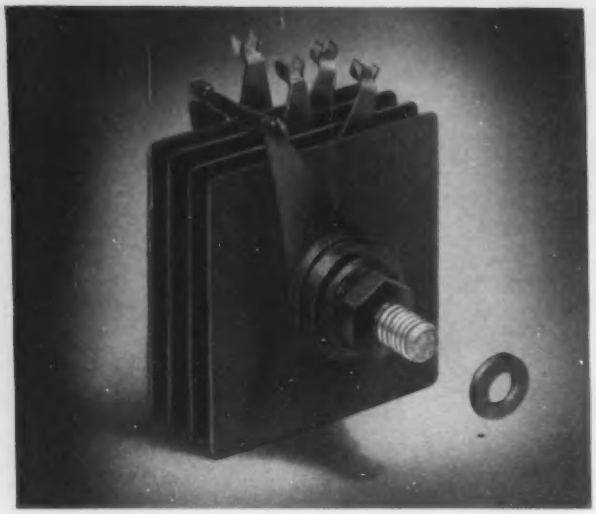
Less expensive Roll Formed Lockseam Tubing cuts costs on all tubing jobs. In many cases it does a better job than more expensive tubing. Lockseam Tubing can be bent as easily as other types. Your tubing is delivered ready for use. Send us your blueprints for steel or aluminum Lockseam Tubing. Let us prove that Roll Formed can help you produce a better product at less cost. For complete details on Roll Formed tubing and special shapes write for Catalog 1053. It tells the complete Roll Formed story.

ROUND SIZES — LOCKSEAM TUBING

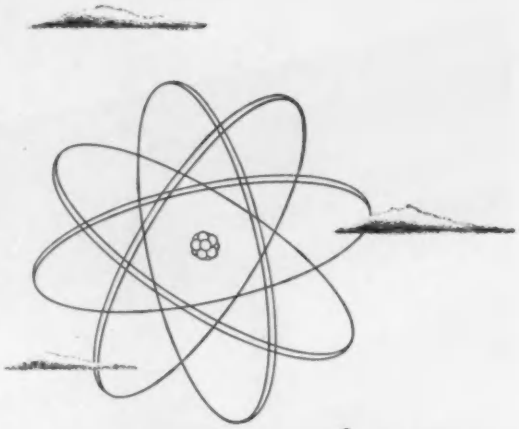
| Section No. | Wall Thickness | O.D. | Section No. | Wall Thickness | O.D. |
|---|---|---|---|---|---|
| 2172 | .018 | ½" | 2096 | .025—.030—.035 | 1" |
| 2173 | .018 | ⅝" | 2020 | .025 | 1⅛" |
| 2103 | .025—.030 | ¾" | 2030 | .030—.035—.040 | 1¼" |
| 2174 | .025—.028—.032 | ⅞" | 2176 | .030 | 1½" |

**ROLL FORMED PRODUCTS**
COMPANY

MAIN OFFICE AND PLANT
3750 OAKWOOD AVENUE • YOUNGSTOWN, OHIO

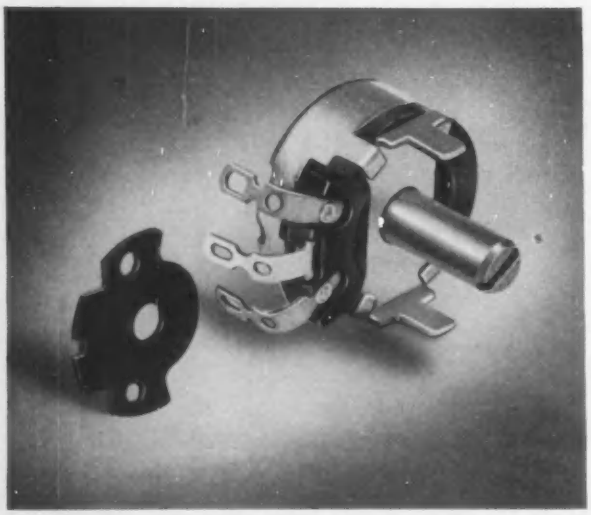


**DC FROM AC.** *In this selenium rectifier for TV use, washers made from Grade 353 give dependable, long-lasting insulation of the current-carrying plates . . . are dimensionally stable . . . provide good mechanical strength at all operating temperatures.*



# *Progress in electronics—*

# profits by plus

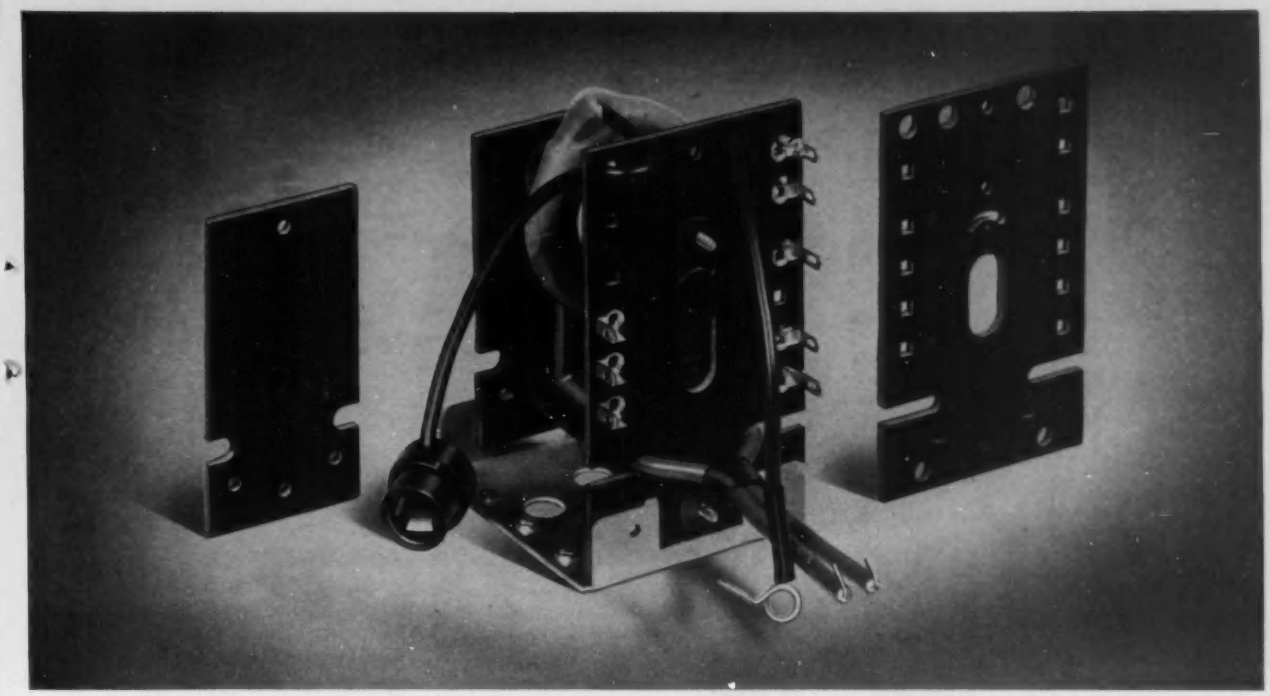


**STABLE CONTROL.** *The rotor spacer in this volume control, punched from Taylor XXXP-301 laminate, keeps the critical electronic circuit insulated from ground regardless of humidity and high temperatures . . . contributes to stability and long life of the component.*

TECHNOLOGICAL advancement in electronics is proceeding at breath-taking speed . . . demanding new and higher standards for insulating materials. To meet these increasingly stringent requirements, Taylor has developed a revolutionary family of hot-punch laminated plastics that offer *premium properties without premium prices.*

You are invited to investigate these new laminates for applications in products now in the development stage. You'll find their superior combination of electrical, physical and fabricating properties will speed the transition of laboratory ideas into production line realities. Investigate them, too, for use in existing products, as a means of effecting real production savings and performance improvements.

*For complete specifications on these new materials, and technical assistance in their application to your products, write or call . . . .* **TAYLOR FIBRE CO.**



**LIGHT ON THE TV PICTURE.** *This flyback transformer for well-known television sets is literally surrounded by the new Taylor laminates. The front panel, which must withstand high voltages, is punched from top quality grade XXXP-301 laminate to assure high insulating properties under humid conditions. The back plate, which has a less demanding electrical job to do but an equally difficult structural responsibility, is punched from economy-priced Grade 354.*

# properties of new Taylor laminates

These new Taylor laminates are like nothing you've ever used before. They're uniform all the way through . . . no surface overlay of resin. They offer you insulation resistance, water absorption, power factor and dimensional stability that meet or exceed the tightest specifications . . . plus exceptional ease in punching and staking with no cracking or checking . . . *and Taylor's unique method of manufacture assures these characteristics consistently.* Four different grades were specifically developed to serve the wide range of requirements of the electronics industry.

**XXXP-301**—Top Grade Laminate—the ultimate in electrical qualities . . . unusually high insulation resistance under all conditions . . . low water absorption . . . excellent punching and staking . . . phenomenal recovery properties . . . premium in every way but price.

**XXP-351**—a high grade laminate second only to XXXP-301 in quality, with closely comparable characteristics at a lower price.

**Grade 353**—a quality laminate with outstanding electrical and physical properties, priced for economy.

**Grade 354**—easily fabricated laminate with good stability, low water absorption . . . at an economical price.

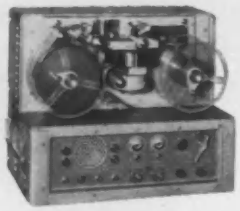
All grades are available in the big, convenient standard Taylor sheet size of 49″ by 49″.

• • •

*Branch offices in Atlanta; Boston; Chicago; Cleveland; Dayton; Detroit; Indianapolis; Los Angeles; Milwaukee; New York City; Philadelphia; Rochester; San Francisco; St. Louis; and Tolland, Connecticut. Distributors in Grand Prairie and Houston, Texas; Jacksonville, Florida; New Orleans, Louisiana; and Toronto, Ontario.*

***Plants in Norristown, Pa. and La Verne, Calif.***

**TAYLOR**
**Laminated Plastics**
**Vulcanized Fibre**

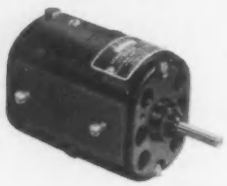
THE NEW  24-HOUR TAPE RECORDER

BY SOUNDSCRIBER . . . THE LAWN SCOUT

ELECTRIC TRIMMER BY WESTERN

# . . . the fractional H.P. motors

# by HOWARD



**Universal and Direct Current Motors** 1/1000 to 1/2 h.p.

**Shaded Pole Motors**—1/2000 to 1/8 h.p.

**Induction Motors**—1/1400 to 1/4 h.p.

Western Tool & Stamping Company, makers of the famous Homko Power Mowers and Lawn Scout lawn equipment, found an easy solution to their motor problems with Howard's 11 B universal motor. Millions of these Howard motors are in use on equipment of all types. A proven, dependable performer in ratings from 1/40 to 1/12 h.p., this small Howard motor handles big jobs at low cost.

SoundScriber Corporation engineers report as follows on Howard's precision induction motors that serve many of today's finest electronic manufacturers:

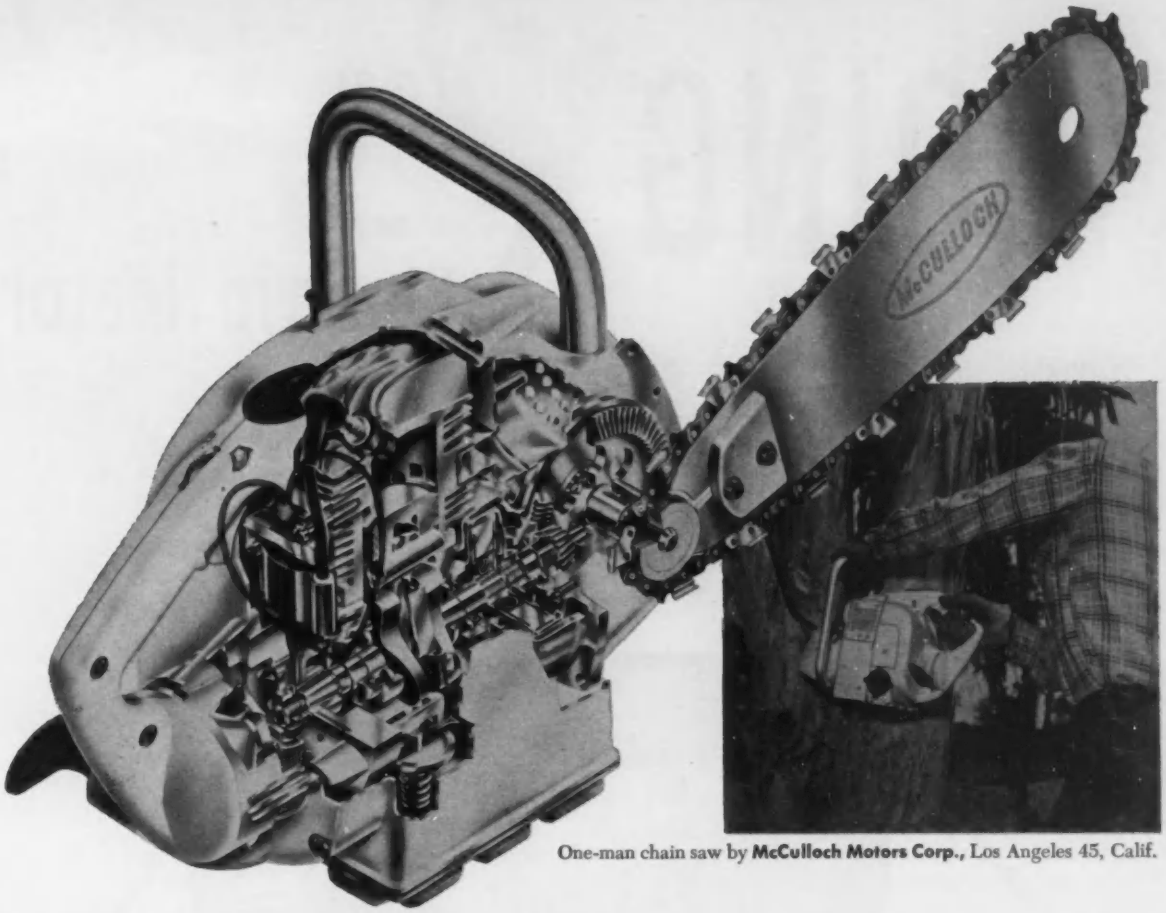
1. The "construction is substantial for extremely long life of bearings, etc., necessary for a device running 24 hours a day continuously."
2. "Dimensions fit small space, yet torque is excellent."
3. "Ventilation and temperature rise are highly satisfactory."
4. The "motor is smooth running and vibration-free without excess noise."
5. "The manufacturer's representatives and factory engineering were extremely cooperative in making necessary slight modifications to meet the pertinent military specifications."

The two products featured above are just two of hundreds of products that are powered by Howard fractional h.p. motors. If you use motors, check your requirements with Howard today. For quick action, just phone Racine 2-2731 or write. Please address Chief Sales Engineer.

DEPT. PE-8 • HOWARD INDUSTRIES, INC. • RACINE, WISCONSIN

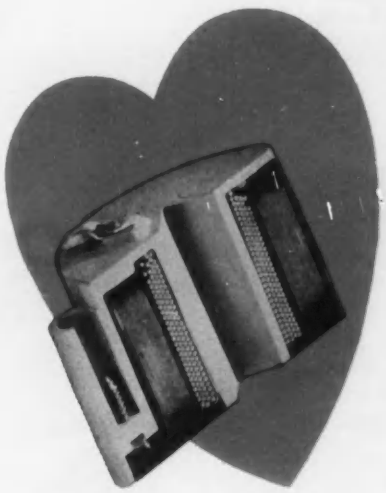
*SALES OFFICES: 208 S. La Salle St., Chicago 4 • 942 S. La Brea Ave., Los Angeles 36 • Room 4822, Empire State Bldg., New York 1*

DIVISIONS: EMC ELECTRIC MOTOR CORPORATION CYCLOHM MOTOR CORPORATION REP RACINE ELECTRIC PRODUCTS




One-man chain saw by **McCulloch Motors Corp.**, Los Angeles 45, Calif.

# HARD PLASTIC HEART MEANS AN ALL-WEATHER START



Cross-section of coil shows BAKELITE Epoxy Resins forming dark area. Note how they have completely filled crevices between the finest wires.

Wet weather, cold weather, high altitudes or low, the motor in this tough little 20-pound chain saw is sure to start. Safely embedded in a solid block of BAKELITE Epoxy Resin, its magneto and coil stay in permanent working order.

If your electrical applications have to work under similarly rugged conditions, you'll find that potting and encapsulating with BAKELITE Epoxy Resins offer an ideal solution. The liquid resin, mixed with its liquid hardener, is simply poured into place. It fills the tiniest crevices, completely protecting the coil from moisture—no electrical shorts result.

In a few hours at room temperature, without applied heat, the mixture changes to a permanently hard solid. There is practically no shrinkage. The smallest components are set firmly and immovably.

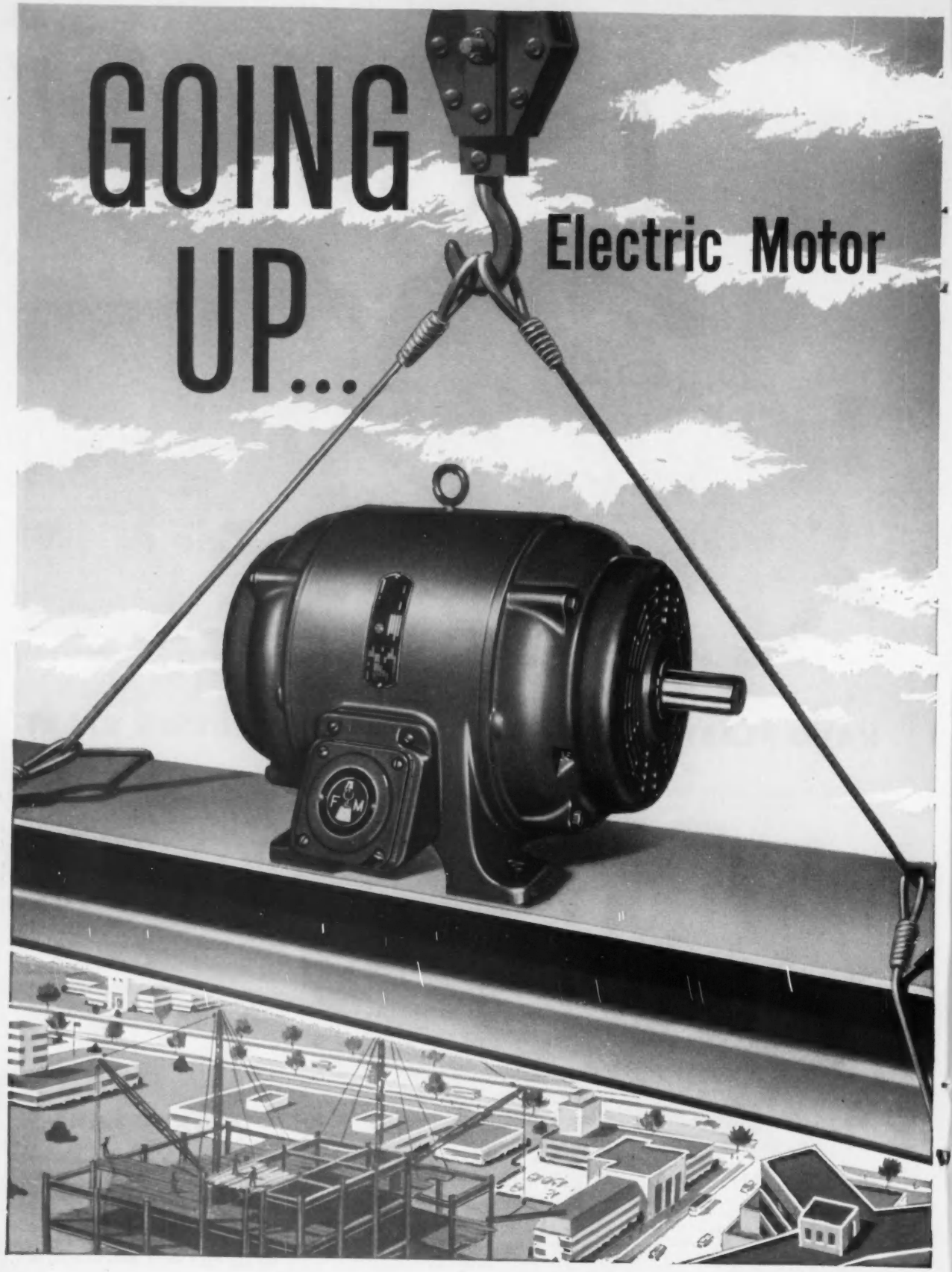
BAKELITE Epoxy Resins are resistant to moisture, oils and greases, chemicals, most acids and strong alkalies. Their dielectric strength and adhesive properties are excellent. They are relatively light in weight.

Perhaps they can help build extra service features into your product. For detailed information on BAKELITE Epoxy Resins, and a list of suppliers, write Dept. XR-10.

**BAKELITE**
TRADE-MARK
**EPOXY RESINS**

TRADE MARK

**BAKELITE COMPANY**
*A Division of*
*Union Carbide and Carbon Corporation*
UCC
**30 East 42nd Street, New York 17, N. Y.**


GOING UP...
Electric Motor

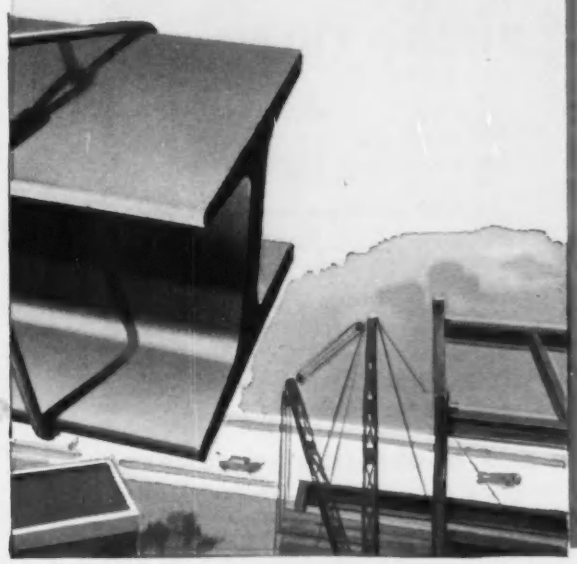
# Performance!

To a towering structure of design achievement Fairbanks-Morse adds still another outstanding member . . . a compact new enclosed motor . . . backed by an engineering tradition which has been a-building for more than a century.

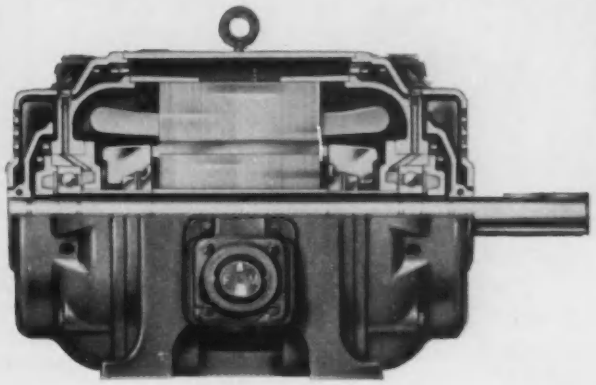
That tradition is
*More Performance in Less Space.*

You, as a buyer of electric motors, will benefit by that tradition . . . just as the users of Fairbanks-Morse diesel engines, pumps, scales, locomotives and the many other F-M products are today enjoying the advantages of finer performance.

Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Illinois.



## NEW FAIRBANKS-MORSE
## TOTALLY ENCLOSED FAN-COOLED MOTORS



**TOTALLY ENCLOSED**—Wherever adverse operating conditions are encountered, F-M totally enclosed construction effectively insures electrical parts and bearings against contamination by dirt, abrasive dusts, metal particles, corrosive gases and steam.

**DOUBLE-END VENTILATION**—Cooling air is drawn through guarded openings in both fan shields and uniformly circulated through cored passages surrounding the sealed inner shell. Efficient heat-transfer action insures uniform internal cooling. Exhaust air is discharged through bottom of frame—not across motor and driven machine.

**COPPERSPUN ROTOR**—Exclusive Fairbanks-Morse feature—an indestructible one-piece rotor—homogeneous, free from flaws for maximum strength and lifetime service.

**CONDUIT BOX**—New, gasketed, cast iron conduit box permits easy pulling of cables without insulation damage. Fairbanks-Morse exclusive: recess feature allows elimination of conduit box where space is limited.

**BEARINGS**—Precision ball bearings are effectively sealed against grease leakage and contain ample lubrication for extended periods of rugged service. Convenient means are provided for flushing and relubricating if desired. Cartridge bearing construction is standard on all larger ratings.

**FAIRBANKS-MORSE**
*a name worth remembering when you want the best*

ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • PUMPS • SCALES • RAIL CARS • HOME WATER SERVICE EQUIPMENT • FARM MACHINERY • MAGNETOS

*See what adhesives are doing today!*

PHOTO COURTESY OF MUSKEGON PISTON RING CO.

# "Unitizing" piston rings

3M COMPANY

Anyone can appreciate the task of inserting a multiple-piece piston ring into place. It takes time . . . and time costs money!

That's why more and more auto makers and repair shops are using "unitized" oil control rings. They're pre-assembled. Spacer and rails are bonded into a one-piece ring through the use of a 3M adhesive.

As a result, these rings are easier to handle, easier to install, saving money for manufacturer and consumer. The adhesive used is well suited for this application. It dissolves in engine oil, leaving ring elements separate for efficient operation after the first run.

**See what adhesives can do for you . . .**

This is an example of how 3M adhesives cut costs. Your 3M sales representative would like to tell you of other instances. For details, call him in. Or, for a free factual booklet, write today to 3M, Dept. 48, 417 Piquette Ave., Detroit 2, Michigan.

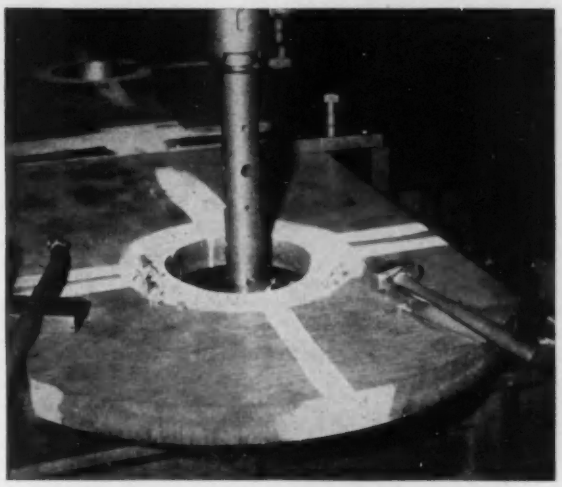
see our catalog in PRODUCT DESIGN FILE or write for copy

*ADHESIVES AND COATINGS DIVISION* **MINNESOTA MINING AND MANUFACTURING COMPANY**

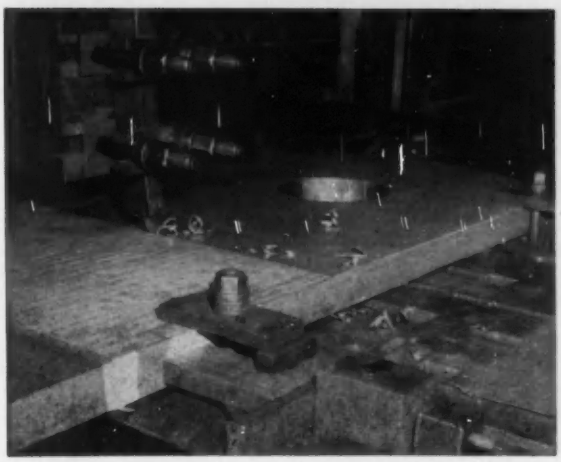
417 PIQUETTE AVE DETROIT 2, MICH • GENERAL SALES OFFICES ST PAUL 6 MINN • EXPORT 122 E 42 ST N Y 17, N Y • CANADA, LONDON, ONT

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

Burning the pin holes. Flame-cutting was also used to round the ends.



Boring the pin holes to finished size for 12-in. diameter hanger pins.



Planing the surface of the hanger to conform to angle formed between two connecting girders.

# Bridge hanger-links show workability of this high-strength, low-alloy steel

The eight hanger-links for the Passaic River Bridge, on the New Jersey Turnpike, provide an excellent demonstration of the workability of high-strength, low-alloy Mayari R. Located at each end of the 990-ft continuous girder—longest ever built in this country—these hangers connect the bridge to the approach spans.

The hangers were fabricated of 3-in. Mayari R plate at Bethlehem's Pottstown, Pa., works. Flame-cutting was used to round off the ends. Holes for the 12-in. hanger pins were also cut by burning. They were then bored to exact diameter.

Planing came into the picture, too. Because of a slight curvature in the bridge, the adjoining girders came together at an angle of 1 deg, 5 min, 14 sec, which of course meant that the hanger pins had to be out of parallel. This made it necessary to plane the hangers in such a way that both the upper and lower portions would bear evenly against the respective girders.

All these operations were accomplished as readily with Mayari R as they would have been with structural carbon steel. And Mayari R can be worked easily in other ways, too—riveting, cold forming, hot forming, shearing, punching. Its use is spreading rapidly, as you will discover if you leaf through our new Catalog 353. Write or call our nearest office for a copy.

BETHLEHEM STEEL COMPANY

BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

**Mayari R** *makes it lighter... stronger... longer lasting*

# new

**. . . and more efficient, too!**

- Custom-designed for regular production!
- Built for a lifetime of service!

# LELAND LOADSTAR MOTORS

**Here are LELAND'S outstanding qualifications for producing the finest of motors to the new NEMA standards:**

★ Extensive and continuing experience in developing and producing, for our Armed Forces, hundreds of thousands of *portable* generator units and *airborne* inverter units and controls. Leland designs consistently meet and frequently surpass specifications so satisfactorily that they virtually become the criteria for other suppliers.

★ More than 33 years' "creative electrical engineering" experience in supplying manufacturers with high-quality custom-built special motors, or standard LELAND motors adapted to the particular requirements of their products.

★ The combined, industry-wide engineering and development resources of American Machine & Foundry Company.

★ A unique combination of modern, mass-production facilities and custom craftsmanship, resulting in extra care in critical operations and greater versatility in production.

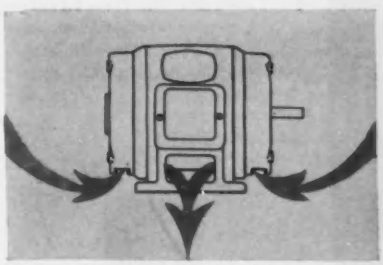
# A completely new line of motors!

**more power-packed . . . *higher in efficiency* . . . lighter in weight . . .**
**smaller . . . better protected . . . quieter running . . . more efficiently cooled**
**. . . more flexible . . . easier to install . . . modern in appearance**
**. . . and maintenance-free!**

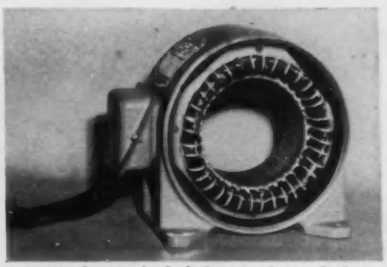
COMPARE this new polyphase, dripproof LELAND *"Loadstar"* motor point by point, feature by feature —the way we do at the factory—with all leading makes of motors! See if you, too, don't find it even further ahead of competition than previous LELAND motors, prior to rerating!

Users of LELAND motors have been enjoying outstanding performance, extra capacity and greater durability for a long time . . . perhaps unaware that these characteristics were often due to LELAND's advance use of improved electrical steels and high-dielectric insulating materials, which have *made possible* the new NEMA ratings!

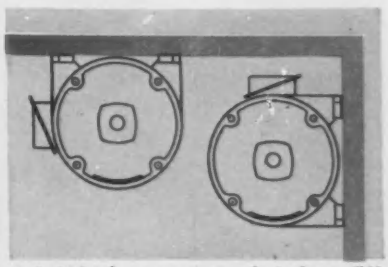
This completely new line of *"Loadstar"* motors carries over, with added refinements, many time-proved LELAND features. Others, entirely new, reflect LELAND's unique experience and creative engineering. Some of these are shown below. For the complete story and frame dimension details, *write for Bulletin No. 103.*



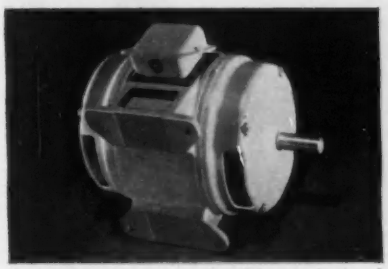
**Cooling:** (by convection) dual fans draw air in both ends, discharge through center vents; (by conduction) through partial stator-core-to-outer-shell contact, shown in cut at right.



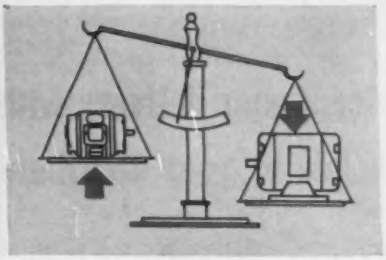
**Leland's** denser, high-dielectric slot and phase insulation takes less room, permits more copper in each slot, increases efficiency and aids heat transfer.



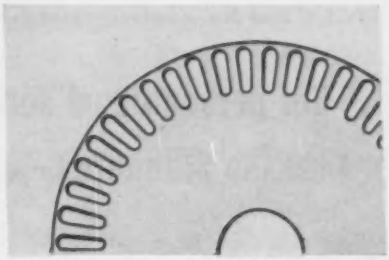
**End shields** have openings only in lower 70° . . . can be rotated for dripproof mounting on wall or ceiling. Drip cover provides for vertical dripproof mounting.



**Rigid** cast iron center and end frames (painted gray) assure accurate rotor alignment.



**New motors** take up to 40% less space; save as much as 33% in shipping weight.



**Closed** rotor slots and preloaded ball bearings eliminate whir and rattle heard in many motors.

New "Loadstar" polyphase, dripproof motors in 1, 1½ and 2 HP (180 frames) now ready. Totally enclosed and explosion-proof frames—also higher horsepower and single phase motors—available soon.

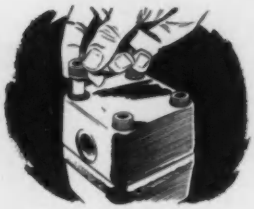
Another AMF Product

**LELAND MOTORS**

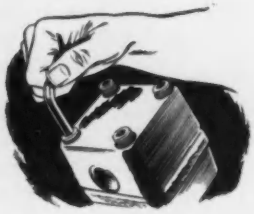
LELAND motors in previous NEMA standard frames will continue to be available for replacement and the convenience of present customers.

**THE LELAND ELECTRIC COMPANY, DAYTON 1, OHIO,** *Division of American Machine & Foundry Company*

**Four UNBRAKO Socket Head Cap Screws** speed assembly in the plant, and reassembly in the field, of these flow-control valves providing 16 different inlet-outlet flow direction combinations.



The knurling on the head of the screw permits faster assembly, because it provides a slip-proof grip.



The uniform depth and size of the hex socket assure maximum torque in wrenching. The accurate diameter of the head permits countersinking.

UNBRAKOs—made of heat treated alloy steel—have fully formed threads, Class 3 fit; controlled fillet and continuous grain flow for strength. Supplied in standard sizes from #4 to 1".

## Get personalized service, faster delivery with UNBRAKO Standards—stocked by your distributor

When you use UNBRAKO socket screw products, you get the finest socket screws made, *plus* the personalized service and the faster delivery of your local distributor. And he enables you to cut your inventory, set up more space for production. For more information, write for UNBRAKO Standards—a complete listing of precision socket screw products carried by your distributor. STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.

UNBRAKO® SOCKET SCREW DIVISION

SPS

JENKINTOWN PENNSYLVANIA

# *New* MALLORY TIMER SWITCH

## *may be just what your product needs*

Looking for a way to time the cycles of automatic dryers, air conditioners, food dispensers, semi-automatic washers? The new Mallory Model W Timer Switch was designed for these and similar applications requiring ratings around ¾ horsepower.

It's exceptionally compact . . . takes a panel depth of only 1¾ inches.

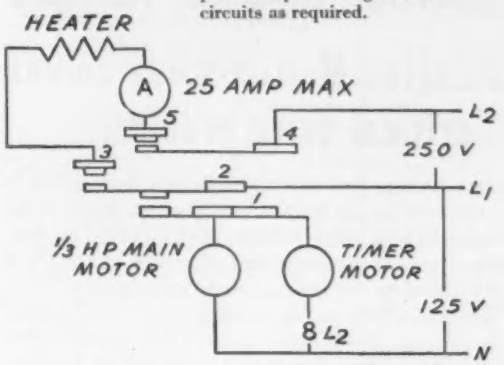
It's versatile . . . switches as many as three separate circuits. It can be used, for example, to control a motor reversing circuit, heater and its own timer motor.

Standard speeds provide cycles of 32, 64, 96 and 192 minutes per cam shaft rotation. Longer cycles up to 24 hours can be supplied. Fabricated cams let you select the exact cycle required for your product. A friction clutch allows the shaft to be rotated manually in either direction.

The new switch has every feature you want for economical assembly on your production line. Spade terminals save space, and speed connections. No bulky mounting hardware is needed.

Built into this switch is the extensive experience that Mallory has gained in designing and manufacturing timers and switches by the millions, for scores of leading appliances. For complete data and a discussion of how it can be advantageously applied in your product, write or call Mallory today.

Typical application of timer switch uses full switching facilities: one circuit controls main motor and timer motor; two others control heater and auxiliaries. Further variations are readily possible by omitting switch circuits as required.

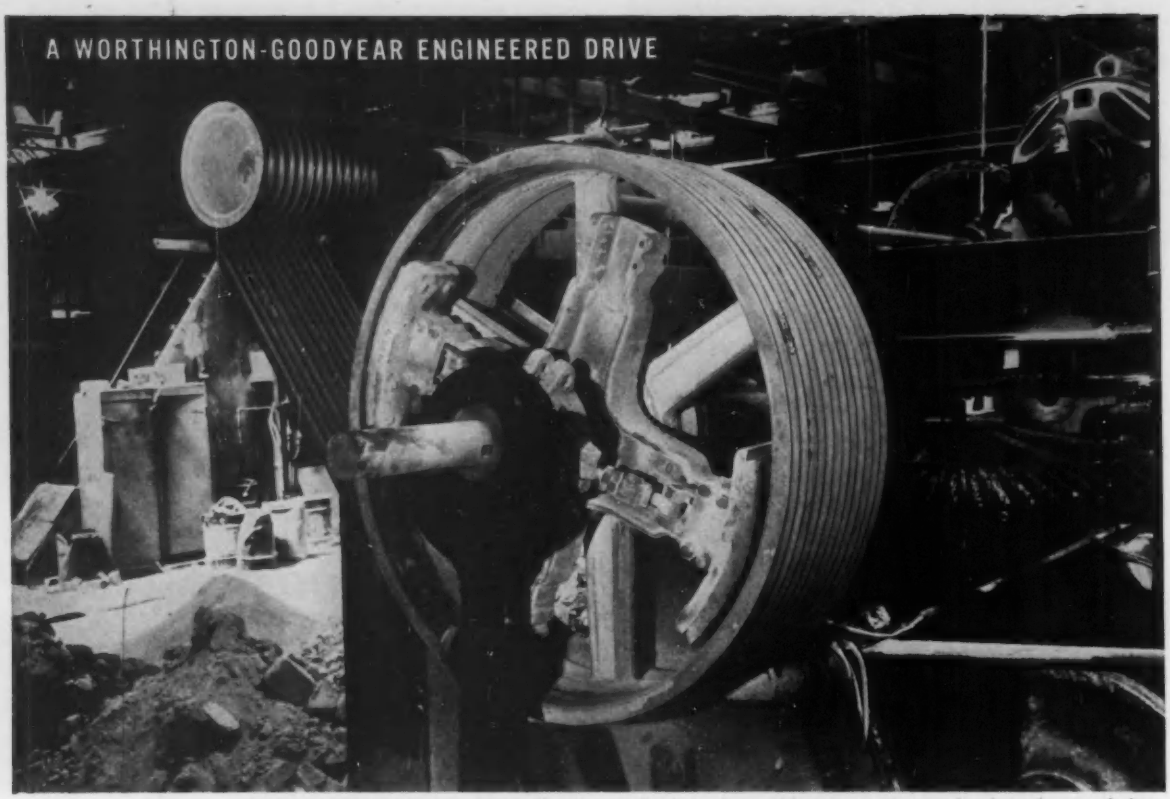



***Expect more . . . Get more from*** MALLORY

**Serving Industry with These Products:**

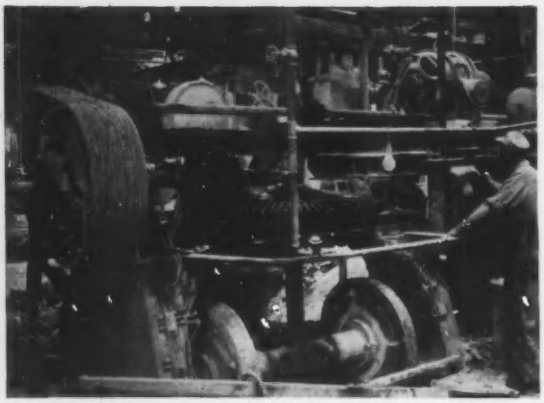
**Electromechanical**—Resistors • Switches • Television Tuners • Vibrators
**Electrochemical**—Capacitors • Rectifiers • Mercury Batteries
**Metallurgical**—Contacts • Special Metals and Ceramics • Welding Materials

P.R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA




**WORTHINGTON MULTI-V-DRIVE** takes heavy shock loads on this wet-pan that crushes huge lumps of clay.

# Belts hold as machine crushes 120-lb lumps



**SMOOTH, NON-SLIP DRIVE** for this wet-pan is provided by Worthington QD sheaves and Goodyear V-belts.

## Worthington Multi-V-Drive solves critical drive problem

Driving a machine that crushes, mixes and tempers crude clay is a real workout for any mechanical power transmission setup—especially with lumps weighing as much as 120 pounds.

After two years of this heavy-duty operation, not one belt has been replaced on this wet-pan. And there's no noise, slippage of belts on sheaves, and no resulting power loss. Because of this fine record, Worthington Multi-V-Drives, with QD* sheaves and Worthington-Goodyear V-belts, will be installed on other wet-pan pulverizers.

Find out how this Worthington-Goodyear drive team can pay off for you, too. Write us. Worthington Corporation, Section MV.4.5, Oil City, Pa. *Reg.U.S.Pat.Off.

MV.4.5

**WORTHINGTON**

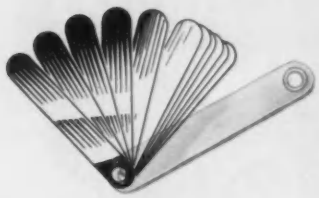
**SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON *YOUR* EQUIPMENT**

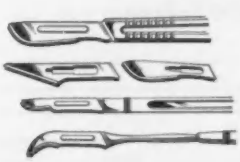
**Compressors • Pumps • Multi-V-Drives • Variable Speed Drives**

# Applications unlimited

with

# NATIONAL-STANDARD
## Wire and High Carbon Strip

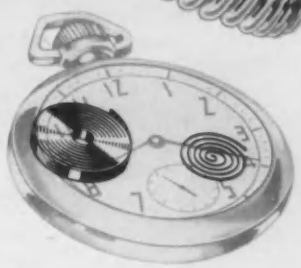


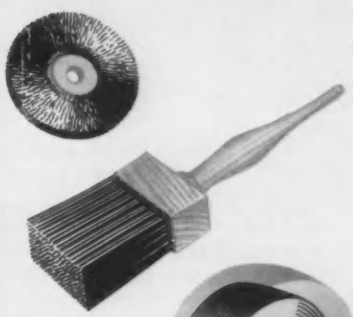


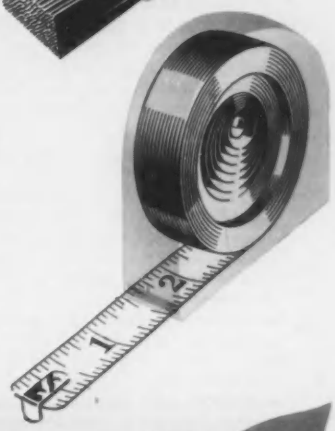
The many and varied applications of National-Standard special-purpose steel are practically unlimited. Every day, new products and new manufacturing methods are developed that more than ever demand the precise control, high quality and uniformity that only National-Standard specialization offers.

Here we produce steel, wire and strip, to meet unusually severe specifications and are constantly developing special types for new uses. Glad to cooperate with you in best meeting your needs, National-Standard offers an enviable 48-year record of supplying outstanding material, workmanship and service to end-use manufacturers.

For additional information or engineering assistance, write to the appropriate National-Standard Division listed below.







DIVISIONS OF NATIONAL-STANDARD

NILES, MICHIGAN

**ATHENIA STEEL, CLIFTON, N. J.**
Flat, High Carbon, Cold Rolled Spring Steel

**NATIONAL-STANDARD, NILES, MICH.**
Tire Wire, Stainless, Fabricated Braids and Tape

**REYNOLDS WIRE, DIXON, ILLINOIS**
Industrial Wire Cloth

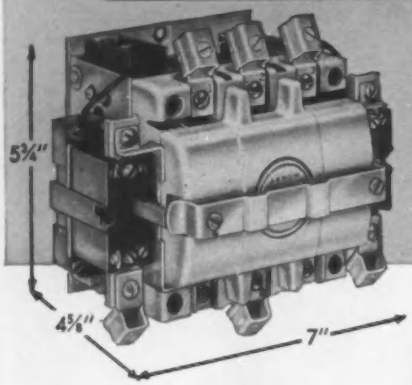
**WAGNER LITHO MACHINERY, JERSEY CITY, N. J.**
Metal Decorating Equipment

**WORCESTER WIRE WORKS, WORCESTER, MASS.**
Round and Shaped Steel Wire, Small Sizes

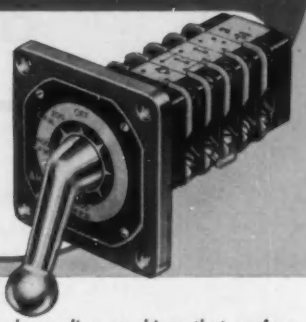
# AUTOMATION BRINGS PROGRESS AND PROBLEMS

## ARROW·HART ADVANCED DESIGN ELECTRICAL CONTROLS

## HELP YOU SOLVE THEM!




SIZE 2 STARTER



"PPS" PUSH-PULL SELECTOR SWITCH

*Industry, in its march toward automation, is demanding machines that perform more functions automatically. This means that machines are becoming increasingly more complicated; the problems of space and weight are more acute than ever before. More . . . and more complicated . . . electrical controls are required, and there is less space available to accommodate them.*

These problems create a major challenge to Machinery Designers . . . and here are only 2 of the outstanding Arrow-Hart Controls that can help to meet it.

### "PPS" PUSH-PULL SELECTOR SWITCH

- **SAVES SPACE 2 IMPORTANT WAYS**
  — **BECAUSE IT IS THE *ONLY PILOT DEVICE* REQUIRED** where push buttons and selector switch were formerly used.
  — **BECAUSE IT MAKES A *SINGLE MAGNETIC CONTROL* DO THE WORK OF MANY** . . . reducing the number of starters, contactors, relays etc. required by a machine.
- **CUTS COSTS**
  — **BECAUSE THERE ARE FEWER CONTROLS TO BUY, MOUNT, WIRE, INSPECT AND MAINTAIN.**
- **PROVIDES MORE CONVENIENT, SAFER SINGLE-POINT CONTROL FOR MULTIPLE OPERATIONS**
  — **UP TO 16 MACHINE FUNCTIONS** can be controlled by a single, compact "PPS" Switch. The operator can move from any position on the dial to any other without activating any of the intervening circuits.
  — **PROTECTS MACHINE and OPERATOR** because one operation can be stopped before another is started if this sequence is desired. Position of single handle always indicates the last operation performed.
  — **CUSTOM MADE FROM STANDARD COMPONENTS,** the "PPS" provides unparalleled versatility, assures the best, most convenient control for any application at lowest cost.

### "RA" RIGHT ANGLE Design MOTOR CONTROLS

- **RADICALLY SMALLER AND LIGHTER** . . . than any other control of comparable rating available anywhere.
- **WITH SUPERIOR PERFORMANCE AND DEPENDABILITY** . . . revolutionary "Right Angle" Operating Mechanism — an Arrow-Hart exclusive — utilizes a bell crank fulcrum that multiplies leverage, increases contact pressure and allows a much smaller magnet easily to outperform old-fashioned, direct-acting types.
- **EASIER TO INSTALL, MAINTAIN** . . . Straight-Thru Wiring eliminates looping, U-bending, saves space and time. All wiring, terminals and contacts are easily accessible from the front. Smaller starter size leaves more room for wiring within the enclosure and on the panel board.
- **A COMPLETE LINE** . . . of "RA" Starters and Contactors is available for all your Electrical Control needs.

WRITE NOW FOR COMPLETE INFORMATION

**Use the attached coupon to send for your free copies of "PPS" and "RA" Design Story Folders *TODAY*.**

SINCE 1890

**ARROW·HART**
INDUSTRIAL CONTROL DIVISION
103 HAWTHORN ST., HARTFORD 6, CONN., U.S.A.

**Offices, sales engineers and warehouses in: Atlanta, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Houston, Indianapolis, Kansas City, Mo., Los Angeles, Milwaukee, Minneapolis, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco. In Canada: Arrow-Hart & Hegeman (Canada) Ltd., Mt. Dennis, Toronto. In England: Arrow Electric Switches, Ltd., Ealing, London W5.**

Quality MOTOR CONTROLS • WIRING DEVICES ENCLOSED SWITCHES • APPLIANCE SWITCHES

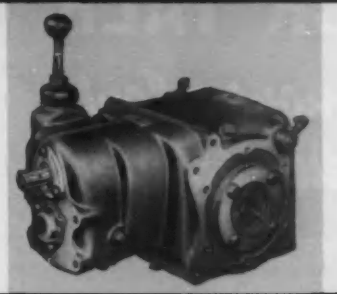
INDUSTRIAL CONTROL DIVISION
**THE ARROW-HART & HEGEMAN ELECTRIC CO.**
103 HAWTHORN STREET, HARTFORD 6, CONN.

Please send my free copies of the Arrow-Hart "PPS" and "RA" Design Story Folders.

NAME _____
POSITION _____
COMPANY _____
CO. ADDRESS _____
CITY _____ ZONE _____ STATE _____ PE

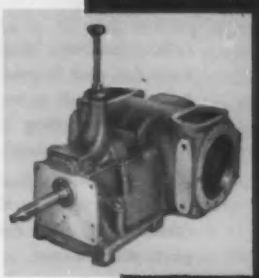
# One way to be certain

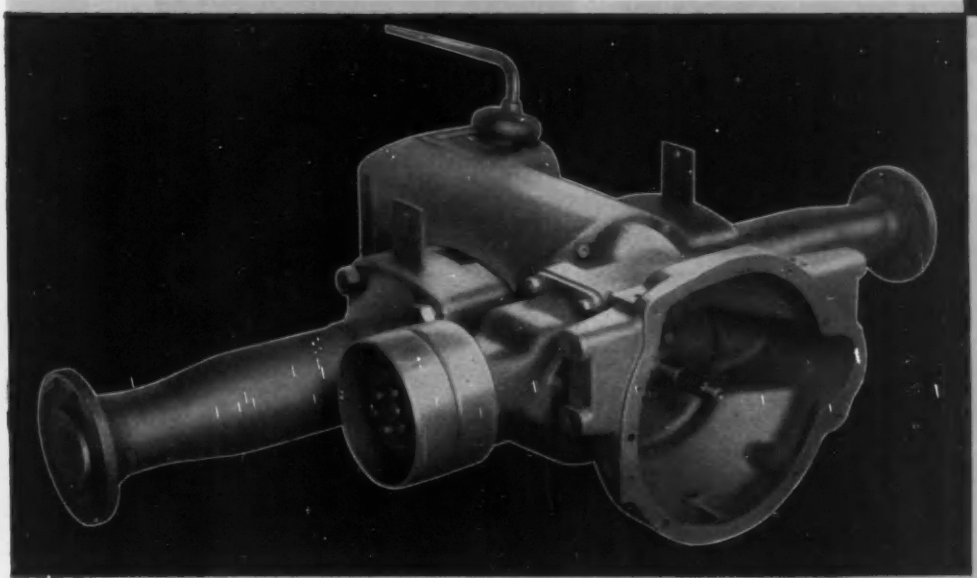
## your design is dependable



At Clark you'll find America's foremost engineering specialists in solving power transmission problems. Why not make use of them—and their years of experience—to make certain that your driving unit is right from the start!

You'll always find, whether your product is agricultural, industrial or heavy duty vehicle that IT'S GOOD BUSINESS TO DO BUSINESS WITH CLARK.





**CLARK EQUIPMENT COMPANY**
BUCHANAN, MICHIGAN
*Other Plants:* Battle Creek • Jackson
and Benton Harbor, Michigan

**CLARK*** **EQUIPMENT**

* TRADEMARK OF THE CLARK EQUIPMENT COMPANY

# 24 HOURS OF "BACK TALK"

## ...but none about these die-cast parts

CASE HISTORIES FROM MT. VERNON FILES

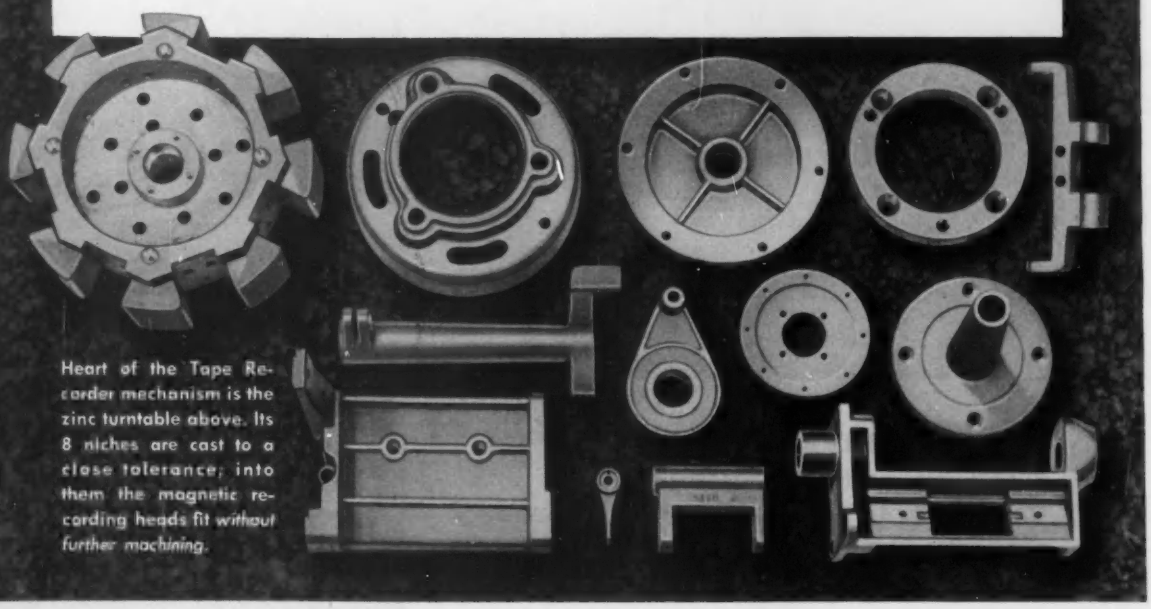
Soundscriber's new 24-hour Magnetic Tape Recorder and Reproducer is the first in its field to provide such a long period of continuous, unattended recording in so small an instrument. It weighs but 80 pounds.

One important reason why this precision instrument is so light, so thoroughly practical, yet so moderate in cost, is the die cast aluminum and zinc parts you see here.

States Soundscriber Corporation: "From long experience with our standard line of dictating equipment, we have found die casting a lower-cost way of making intricate parts. Further, this method allows for more economical use of lightweight metals. Mt. Vernon die casting has always met our high quality standards."

Whatever *your* product, simple or intricate, it will pay you to consult with us. We have up-to-the-minute facilities for precision die casting of aluminum and zinc, and a vast reservoir of experience. It's quite possible that we can show you the way to greatly increased production, lower unit costs —improved products, too.

**MT. VERNON**
**DIE CASTING CORP.**
STAMFORD, CONNECTICUT



Heart of the Tape Recorder mechanism is the zinc turntable above. Its 8 niches are cast to a close tolerance; into them the magnetic recording heads fit *without further machining.*

# Design facts you should know about ALCOA® aluminum and magnesium castings

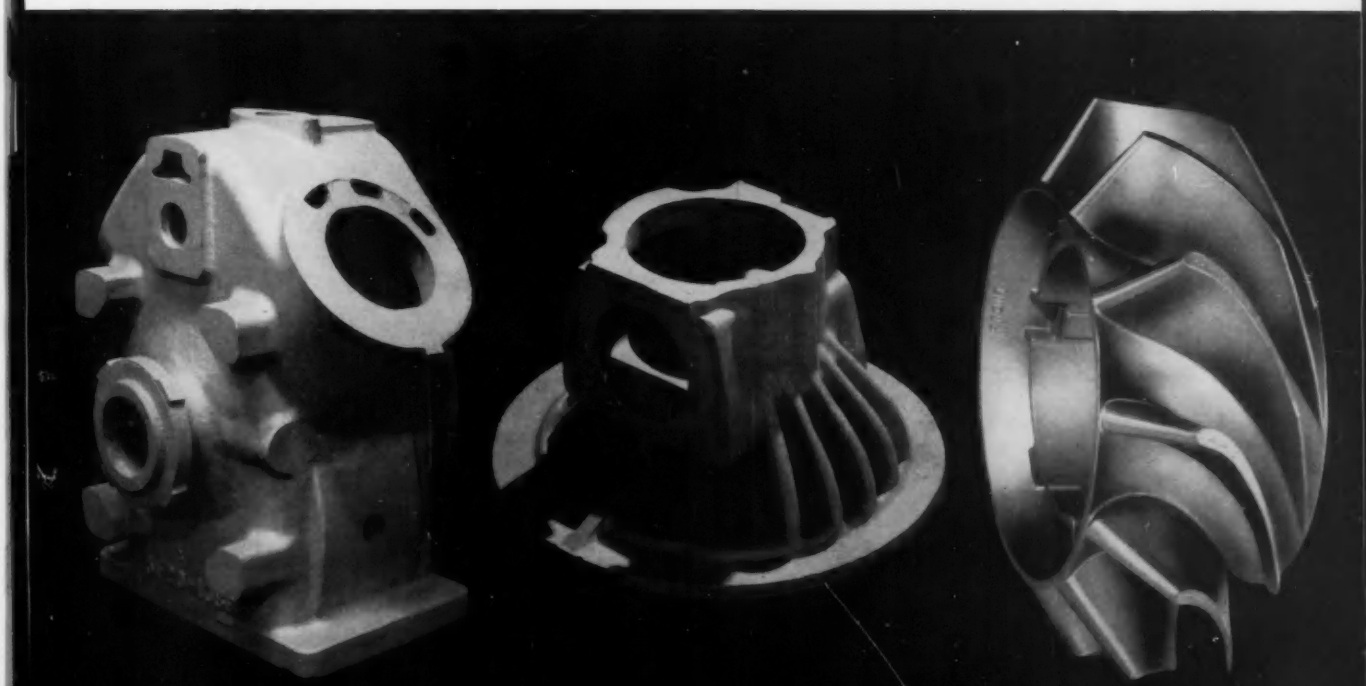
**Latest process techniques and metallurgical advances in Alcoa foundries now make possible stronger, larger and more intricate castings**

In 1953, over 1 million, 200 thousand net tons of primary aluminum were produced—an all-time high. While it is true that much of this metal was fabricated by newer processes, nearly *30 per cent*, or 650 million pounds of that aluminum went into sand, die and permanent mold castings. Still more went into modifications of the basic processes—plaster, investment and centrifugal.

This is not surprising in view of new techniques which now make it possible for us to cast stronger and larger shapes of intricate configuration in Alcoa plants and foundries. Such shapes contribute significantly toward eliminating high-cost "bits and pieces" construction. For example, we're now casting, in sand (plaster cores), hydraulic elements and driving bells for heavy-duty torque converters used in oil well drilling rigs and ship propulsion; permanent mold casting 600-pound spindle bodies; and die casting entire automobile clutch housings.

Metallurgical advances have been made as well. Highly stressed or cyclically loaded airframe sections often ruled out the use of castings. But, a new Alcoa-developed alloy, when used in the heat-treated condition, provides a higher yield strength and better elongation than any of the previous casting alloys. Parts with these improved mechanical properties, mass-produced to close tolerances by the permanent mold process, should find extensive use in airframe structures.

The following pages provide current information on what's being done at Alcoa foundries with aluminum and magnesium castings and suggested tips on alloy selection and design.

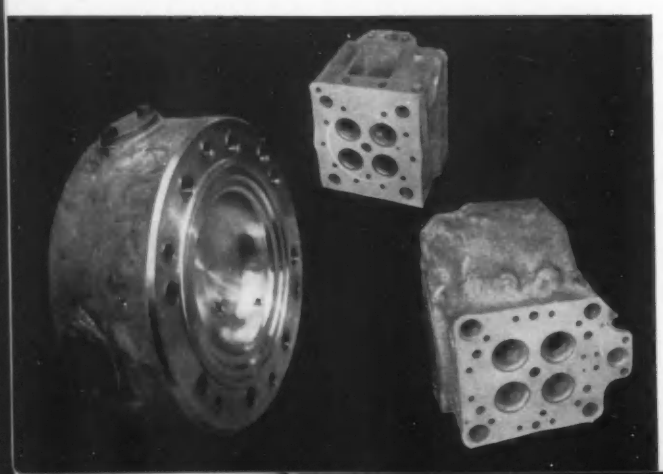


# The casting processes and their applications

## ALCOA PLASTER CASTINGS

Smoother surfaces and greater dimensional accuracy can be achieved with plaster casting than with any of the three previous methods. Once limited to small parts, plaster casting is rapidly coming of age. Tolerances of plus or minus .005 inch per inch are not unusual. This process is particularly suited to making thin, intricate shapes possessing good mechanical properties.

Parts such as these used in heavy-duty torque converters weigh up to 135 pounds and are nearly three feet in diameter. The intricate impeller blades, which must be smooth for even oil flow, are perfect in every detail as they leave the mold. Mold costs, though higher than for sand castings, are justified since simple cleanup and machining for fit are the only subsequent operations necessary.



## ALCOA SAND CASTINGS

Most versatile of the casting methods, sand casting is generally used to make large, intricate shapes. But small to medium-sized parts adaptable to high-speed molding equipment can be produced in large quantities at low cost. Dimensional tolerances can be held to plus or minus ½ inch.

Because of aluminum's high thermal conductivity, temperatures on the surface of this cylinder head do not build up to damaging levels. As a result, fuel injection systems in diesel engines function better. Spark plugs in gas engines last longer. Exhaust valves last longer in both. Sand-cast aluminum cylinder heads weighing up to 650 pounds (for engines) with a 21½-inch bore have been produced in our foundries.

## ALCOA DIE CASTINGS

Alcoa is now producing die castings that vary in weight from a few ounces up to 20 pounds and more and measure up to 84 inches in length. Tolerances of .0015 inch per inch are being maintained (and sections as thin as .045 inch).

Part shown here is a heat pump component used in air conditioning compressor units. Cast in thinner sections than is possible in heavy metal, less subsequent machining is required. An added advantage is light weight—aluminum parts weigh about ⅓ of their cast iron counterparts, and magnesium even less—reducing handling costs in production and shipping.

**ALCOA PERMANENT MOLD CASTINGS**—Where great quantities of identical shapes are to be produced, permanent mold casting is frequently employed. Permanent mold castings have higher mechanical properties, better pressure tightness and greater uniformity than sand castings. Tolerances are good at plus or minus 1/64 inch, plus .002 inch per inch. In some cases, 1/32 inch in five feet has been achieved.

These bearings are used on the roll necks of steel mills where the extreme pressures require a good bearing material. Measuring 20 inches high, 24 inches wide, these castings weigh 225 pounds each. Wall thickness is one inch. Even in permanent mold castings of this size, surfaces are smooth and clean, as cast.

# alloy selection

Of the more than 35 Alcoa Aluminum and approximately 11 magnesium alloys used in the casting processes, there is one which will suit your needs particularly well. For example, there is A132, an Al-Si-Ni-Mg alloy. At high temperatures, particularly from 500 to 600° F, it has excellent mechanical properties and a low coefficient of thermal expansion. Further, it has good machinability. For these reasons, it is often used for automotive and diesel pistons.

Another is 214, an Al-Mg alloy. It has excellent resistance to corrosion and tarnish with good combinations of mechanical properties. Because it responds well to Alumilite* finishing, it frequently is employed in dairy and food-handling equipment, cooking utensils and similar applications.

Magnesium alloys containing rare earths or thorium combine very light weight with good strength at elevated temperatures. The coefficient of expansion of the magnesium alloys is, however, approximately ⅓ higher than that of most aluminum alloys.

Keep in mind that each aluminum and magnesium alloy possesses particular characteristics suited to certain jobs. There is a right alloy for high strength, good electrical and thermal conductivity, weldability, machinability, castability.

# finishes

Alcoa Aluminum and Magnesium Castings can be finished by all possible methods . . . mechanical, chemical or electrochemical. Usually, however, magnesium castings are chemically treated in a simple chrome pickle. Both metals can be painted, but magnesium castings require a little better surface preparation. Electrochemical finishes can be applied, such as the Alcoa-developed Alumilite finish, which put a file-resistant surface on aluminum.

Aluminum castings can be plated with any commercial metal—chromium, zinc, nickel, copper, brass, silver and gold. Electroplating often is justified from both a performance and cost standpoint.

*Trade Name of Aluminum Company of America.

# Design tips

Although each part you may consider as a casting will have problems inherent in it and it alone, there are a few rules that, when followed, are helpful in designing for any of the casting processes. For example:

**DRAFT**—remember that excessive draft adds weight and often produces structural weaknesses caused by uneven shrinkage, leads to a weaker joint. Fillet radii of ¼ inch minimum are usually about right for die castings. Junctions can be made stronger by using ribs or webs.

**TOLERANCES**—casting cost reflects directly tolerances specified. Tolerances should be as liberal as design requirements allow. In the case of die castings, they shouldn't exceed plus or minus .015 inch.

**WALL THICKNESS**—where it is within the limits of your design, maintain equal wall thickness at joining sections to avoid internal stresses. These can and often do cause structural flaws.

**FOOLPROOFING**—if your part is symmetrical, try where possible to design in an unsymmetrical surface such as a boss. This way, the foundry and machine shop will check the casting at the same places, and more important, subsequent machining operations will all be performed on the same surface. Thus, variations caused by inadvertent misalignment of the part during machining can be avoided.

**SECTION STRENGTH**—thin, as-cast sections are stronger than larger sections machined to size. Within certain tolerance limits, they are cheaper. Alcoa castings are held to close tolerances and frequently require only nominal machining.

**COST**—of the casting as it comes from the mold must, of course, be right. Frequently, Alcoa engineers are able to suggest design modifications which make that cost lower. Moreover, the casting skill developed by Alcoa production teams over 66 years ensures against high rejects, ensures that you will not have to operate a repair department for defective castings.

**DIMENSIONS**—to keep pattern cost to a minimum as well as help maintain dimensional accuracy, all dimensions which are in close proximity should, where possible, be designed to be cast either entirely in the cope side or the drag side of the mold.

At all Alcoa foundries—Bridgeport, Cleveland, Buffalo, Detroit or Vernon, California—and die casting plants at Chicago and Garwood, New Jersey, casting specialists will work closely with you in design and alloy selection.

# Your next step

Considerable savings can be effected simply by following the design tips mentioned here. But, actually, the more a designer can learn of foundry practice, the more aware he will be of ways and means of effecting savings in casting costs. A good way to do this is to write for a free copy of Alcoa's book, *Casting Alcoa Alloys*. You can get yours simply by writing us on your company letterhead telling us your job function.

In the meantime, if you have any specific questions about aluminum or magnesium castings, there is an Alcoa sales engineer near you, ready to give you the answers. His office is listed under "Aluminum" in the classified section of your telephone directory. Whether you plan on buying Alcoa Aluminum or Magnesium Castings within the next week, month or year, don't hesitate to use his time and talents freely. That's his job. ALUMINUM COMPANY OF AMERICA, 1992-H Alcoa Building, Pittsburgh 19, Pennsylvania.

see our catalog in
PLANT ENGINEERING FILE
or write for copy

# How Morse equipment helps increase output and efficiency of railroad tie renewal gangs

This complex machine helps railroads protect economically their prime asset, smooth roadbeds. With new Tie Bed Scarifier—produced by Fairmont Railway Motors, Inc.—one operator can dig a uniform tiebed ten feet long in a minute or less. This uniformity, aside from making the insertion of new ties easier, means even support for new ties after tamping, and insures mile after mile of level rail.

The above illustration shows how Morse Power Transmission equipment lends itself to tough design problems. Three Morse Roller Chain Drives and two Morse Flexible Coupling Driveshafts transmit power smoothly from the motor to the three digging drums, and perform efficiently, despite shock loading and abrasive dust from the impacted ballast.

Additional design advantages include: (1) increased drive center distance tolerances, (2) automatic compensation for torsional deflexion and misalignment between motor driveshaft and digging drums, (3) adaptability to the small lateral space available.

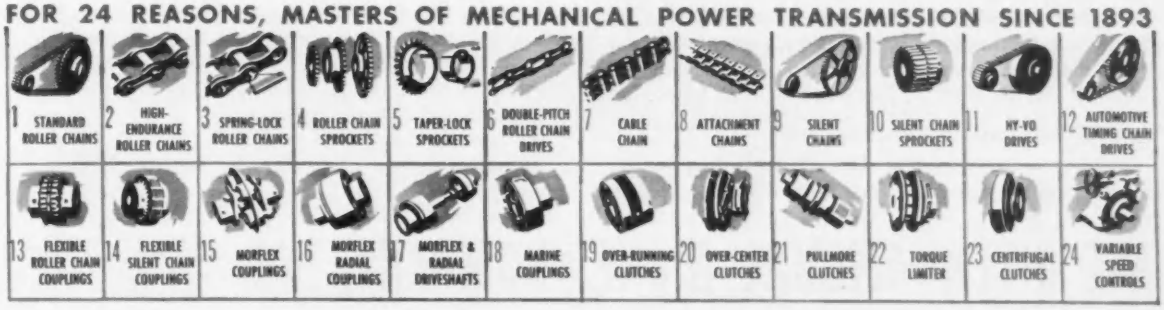
Tough and precision-built, these Morse products give long, trouble-free service life. They require little maintenance, reducing machine downtime to a minimum.

Let us show you how Morse products can aid in your machine designs. A Morse representative is always immediately available to help you on your power transmission needs. Write, today, for more information on the complete line of Morse Power Transmission products.

**MORSE CHAIN COMPANY**
**7601 Central Avenue**
**DETROIT 10, MICHIGAN**

MORSE
MECHANICAL
*POWER TRANSMISSION*
PRODUCTS

**FOR 24 REASONS, MASTERS OF MECHANICAL POWER TRANSMISSION SINCE 1893**



**Conquers Heat, Erosion and Corrosion.** Stainless steels containing nickel lengthen life expectancy of various components used in severe service. For instance, Diesel engine turbocharger rotors. Some rotors operate at from 12,500 to 21,000 r.p.m., and at temperatures upward of 1000°F. The rotor comprises a slotted disc of chromium-nickel stainless steel, with inserted blades of the same material . . . to take the brunt of attack in converting heat into mechanical power. Type "19-9" stainless, containing molybdenum and tungsten additions, is used to make sure of high tensile strength and low creep at the high temperatures encountered. And a somewhat similar austenitic chromium-nickel stainless steel . . . 18-8-S-Mo . . . is used for turbine nozzle blades

# STAINLESS PROVIDES THE ANSWERS . . .

Thousands of designers and engineers have found austenitic chromium-nickel stainless steels to be the key to new high standards of product performance and minimum operating costs. You, too, may find that a stainless steel containing nickel will help solve *your* metal problem.

### 1. At Elevated Temperatures

Stainless steels of this type possess the two essential qualities for successful use at elevated temperatures. By virtue of the chromium content, and assisted by the nickel content, they have outstanding resistance to scaling and oxidation. The nickel content also results in high creep strength and stress-to-rupture properties. Combined, these properties permit use of chromium-nickel stainless even in thin sections required for lightweight design.

### 2. At Sub-Zero Temperatures

Experience has shown that unalloyed steels become embrittled rapidly as temperature is lowered below normal. Nickel is by far the best alloying element to prevent brittleness. At sub-zero temperatures, chromium-nickel stainless steels provide unsurpassed impact values. These steels retain such a high level of toughness that they are known to be useful at temperatures as low as —400°F. and possibly even lower.

### 3. Under Corrosive Conditions

Selection of exactly the right alloy for your specific needs may be made from some thirty alloy steels qualified to carry the family name "Stainless." By virtue of their strength and resistance to attack by chemicals and atmospheres over a wide range of concentrations and temperatures, these austenitic chromium-nickel steels assure not only longer life of the equipment and purity of product, but also permit decrease of bulk and deadweight without sacrificing safety.

### 4. Where Erosion Is A Problem

Chromium-nickel stainless offers the utmost in resistance to erosion and cavitation. By cold working, it is possible to increase the tensile strength to as much as 300,000 psi. When subjected to erosion, the erosive media work hardens the surface and, correspondingly, curbs the attack. This resistance to erosion combined with corrosion resistance results in prolonged life for equipment made from the chromium-nickel stainless steels.

### 5. Use *Stainless* To Meet Complex Requirements

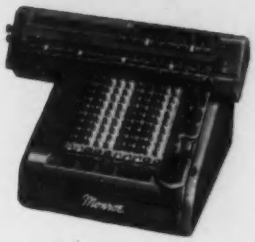
Utilize the unique combination of properties provided by chromium-nickel stainless steels when designing new products or improving old ones. You can draw, spin, forge, weld, solder, punch, shear or bend chromium-nickel stainless steels. Leading steel companies produce these austenitic alloys in all commercial forms. A list of sources of supply will be furnished on request

SYMBOL OF INCO SERVICE

**THE INTERNATIONAL NICKEL COMPANY, INC.** 67 WALL STREET NEW YORK 5, N. Y.

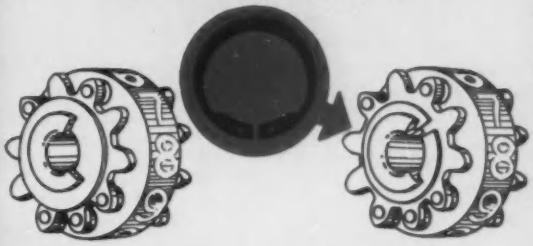
# Waldes Truarc rings replace old-fashioned fasteners . . . save assembly time...end scrap loss...increase operating efficiency

### This is the Monroe Calculator



...precision-engineered business machine made even more efficient, and less costly to manufacture through the use of Waldes Truarc Retaining Rings.

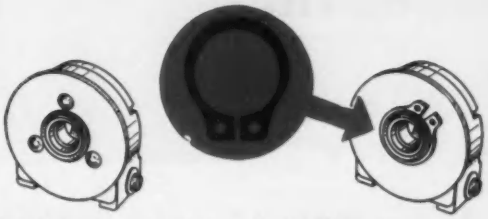
### Multiplier Dial Assembly



**Old Way.** One-piece assembly was spun together. Spinning operation was costly, resulted in high scrap loss.

**Truarc Way.** Two-piece assembly is held together by one Truarc Ring (series 5108). Rejects: practically zero.

### Electric Motor Governor



**Old Way.** Collector Disc assembly was formerly riveted, requiring skilled labor. Riveted Collector Disc could not be removed in the field.

**Truarc Way.** Truarc Ring (series 5100) replaces rivets, saves labor, material...improves Collector action. Collector Disc is easily replaced.

### Intermediate Gear Shaft

**Old Way.** Washer riveted on end of assembly for zoning control. Costly, troublesome, hard to obtain critical zoning required.

**Truarc Way.** Truarc E-Ring (series 5133) cuts assembly time, virtually eliminates rejects and final assembly and zoning problems.

Monroe Calculating Machine Company, Orange, N. J. uses various types and sizes of Waldes Truarc Retaining Rings. Use of Truarc has helped eliminate scrap losses, saved on material and labor, and resulted in increased operating and servicing efficiency of the product. Monroe plans to use Truarc Rings for every possible fastening operation on their entire line!

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered...quick and easy to assemble and disassemble.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc Engineers for individual attention, without obligation.

SEND FOR NEW CATALOG

**WALDES**

**TRUARC**

REG. U. S. PAT. OFF.

**RETAINING RINGS**

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,052; 2,420,921; 2,420,341; 2,439,705; 2,441,840; 2,459,165; 2,483,366; 2,483,383; 2,487,002; 2,487,003; 2,491,306; 2,500,081 AND OTHER PATENTS PENDING

**For precision internal grooving and undercutting... Waldes Truarc Grooving Tool!**

PN086

**Waldes Kohinoor, Inc.,** 47-16 Austel Pl., L. I. C. 1, N.Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

*(Please print)*

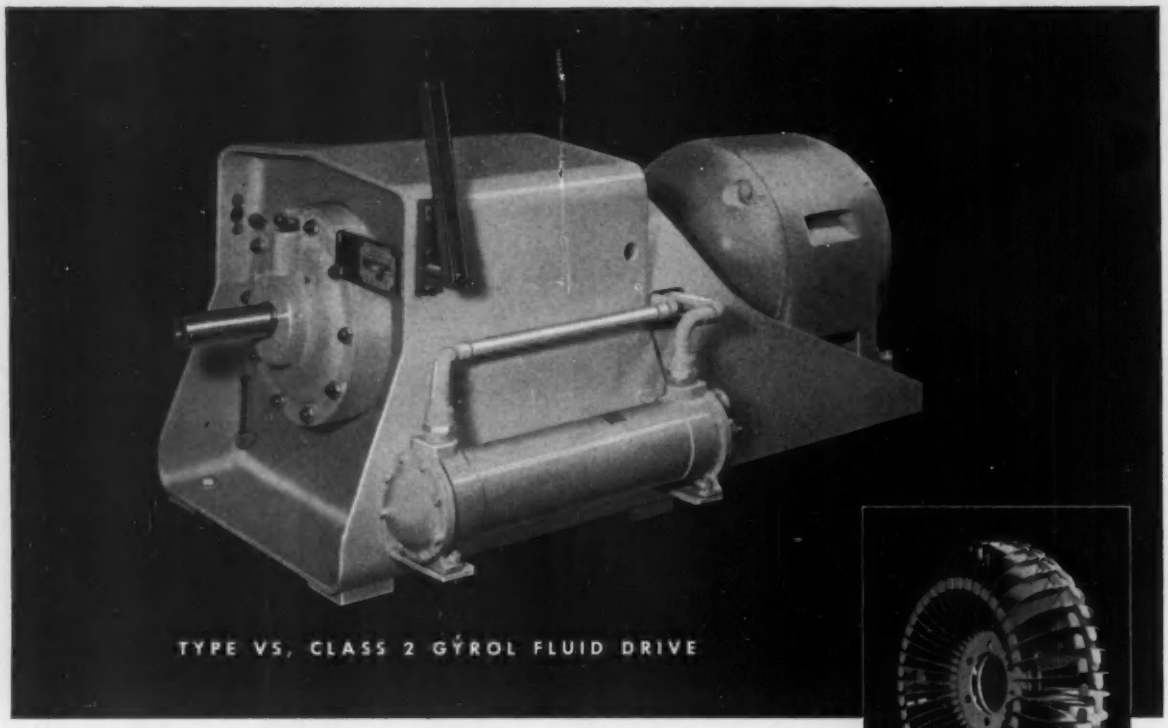
*Name* .....

*Title* .....

*Company* .....

*Business Address* .....

*City* ..... *Zone* ..... *State* .....



TYPE V5, CLASS 2 GÝROL FLUID DRIVE

*Phantom view of driving and driven members.→*

# New *Gýrol* Fluid Drive is reversible while in motion!

**American Blower's new, class 2, adjustable-speed fluid drive offers unlimited application possibilities!**

NEWEST member of the American Blower Gýrol Fluid Drive line, this versatile unit can be reversed while in motion—at any variable operating speed—by merely reversing the direction of rotation of the motor!

You'll find many other big advantages in this compact, self-contained unit for shockless, adjustable-speed control of fans, blowers, centrifugal pumps and compressors—and a wide variety of other industrial uses! Check the features of this new Gýrol Fluid Drive and see if it can be used in your own plant. It's a safe bet you will find several money-saving applications!

Get complete information about the American Blower Class 2, Adjustable-Speed Gýrol Fluid Drive from your nearest American Blower Branch Office. Or write us direct, Dept. 180-7, for your free copy of Bulletins 9419 and 9519. Do it, today!

**FEATURES**

- Can be reversed while in motion by reversing motor
- Speed range 5-1
- Across-the-line starting on many applications
- Motor can reach full speed before engaging load
- A compact, self-contained unit
- Trigger-action response—adjustable speed
- Speed may be controlled manually or automatically
- Six sizes, 7½ thru 800 hp—speeds up to 1800 rpm

**AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN • CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO**
Division of American Radiator & Standard Sanitary Corporation

**YOUR BEST BUY AMERICAN BLOWER GÝROL FLUID DRIVES**

*Serving home and industry:* AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

# *"We've got an economy drive going..."*

"Wow! Am I glad to get off my feet. Those cement floors at the exhibit hall were killing me!"

"Glad to have you stop by. Let's just relax for awhile."

"While we're sitting here, Roy, tell me something. I heard you talking about cutting costs with that fellow from the automobile plant. We've got an economy drive going and I'd like some more ammunition. For example: Wolverine Trufin*—why is that so economical?"

"Trufin is a natural for cutting costs. One-piece construction gives you more heat transfer area in less space. Retubing with Trufin saves the cost of new equipment, boosts output."

"It sounds better all the time, Roy. Keep going."

"Well, we've got the Wolverine Spun End Process†. We take a length of plain tube and, in one simple operation, fabricate it into the shape you need. Spinning can eliminate such operations as deep drawing, swaging, machining and assembly."

"That can save us plenty of time."

"Sure, Bill. You're an engineer—you've got to look at it that way. And you, Jim,—you're a P.A. You've got to consider convenience. You'll be interested in knowing that Wolverine produces tubing of copper (and its alloys), aluminum, and electric-welded steel—prime surface or finned. Then, too, we can give you production-line packaging—safe delivery, easy to handle, easy to store shipments. Remember too, Bill, that you can get technical help from our Field Engineering Service!"

DON'T FORGET: Only Tubemanship can produce such a sparkling economy story as this. You can get full information from our General Products Catalog. Just write. WOLVERINE TUBE, Division of Calumet & Hecla, Inc., 1479 Central Avenue, Detroit 9, Michigan.

*Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.*

† A PATENTED PROCESS RE. 22465
* REGISTERED U.S. PATENT OFFICE

EST. 1916

**WOLVERINE TUBE**

DIVISION OF CALUMET & HECLA, INC.

*Manufacturers of Quality-Controlled Tubing*

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPARTMENT, 11 EAST 48TH STREET, NEW YORK 16, NEW YORK

# Welding eliminated HERE

Welding operation required in two-piece construction was eliminated by cold heading bolt in one piece.

Roll threading permitted faster production at lower cost.

A manufacturer of power lawn mowers uses a bent eyebolt as a mounting brace to adjust the cutting height of the mower blades. The bolt was formerly produced by welding an eye forging to a bolt made on a screw machine . . . and then bending into the shape needed. National was asked how this bolt could be produced faster and at lower cost.

National's "Special Products Service" came up with a method of producing the bolt in one piece by cold heading and roll threading. In this way, the welding operation was eliminated and the manufacturer realized a lower unit cost. Thanks to National's wide range of cold heading equipment and specialized know-how . . . the same type of economy can be offered you.

## Bring your "Special" problems to National

Do you have a fastener or a small part problem that can be solved by National's "Special Products Service"? Our representative will be glad to discuss your needs. Write for free copy of National's "Special" fastener booklet.

**REPRESENTATIVES IN:**

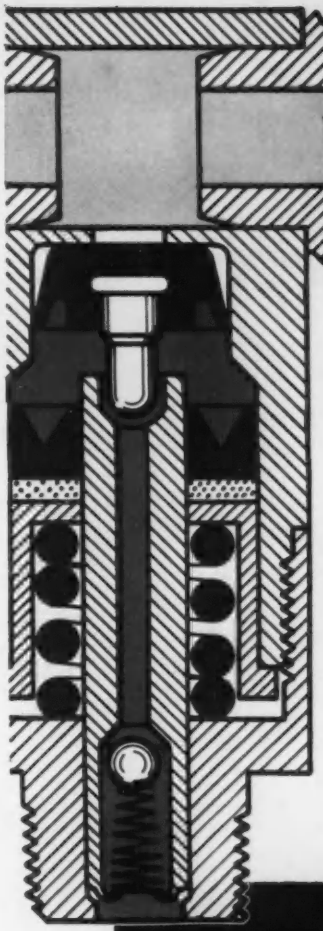
| | | |
|---|---|---|
| Chicago | Kansas City, Mo. | Philadelphia |
| Cincinnati | Lansing | Rochester |
| Denver | Milwaukee | San Francisco |
| Detroit | Minneapolis | Seattle |
| Indianapolis | New York | St. Louis |

**THE NATIONAL SCREW & MFG. COMPANY**
**Cleveland 4, Ohio**
*Pacific Coast:* National Screw & Mfg. Co. of Cal.
3423 South Garfield Ave., Los Angeles 22, Cal.

MANUFACTURERS OF PHILLIPS SCREWS

National PRODUCTS

Fasteners Hodell Chains Chester Hoists



a "lubrication fitting" that out-thinks a man...

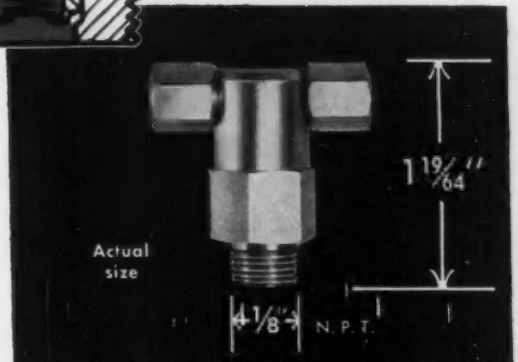
# ALEMITE Accumeter®

## The low-cost, simple way for you to design fool-proof, automatic lubrication into a machine with many small bearings

Many small bearings on a compact, high-speed machine. You know that proper, exact lubrication is essential, but you also know how crowded the bearings will be. You know that they will be difficult or impossible to reach with grease gun or oil can and that some of them will be missed—and the shutdown time for lubrication will be costly.

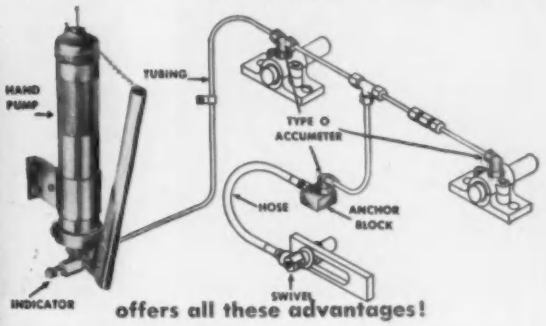
The answer? Alemite Accumeter, the valve that never forgets. This tiny, accurate, and very simple valve automatically meters an *exact* amount of lubricant to the bearing, at exactly the right time, *while the machine is in operation!* Time, maintenance and production costs drop—output soars! That's the reason that better than 95% of all major plants buying machine tools specify centralized lubrication.

Alemite Accumeter Systems are simple and economical to design into any machine—and there is a system perfect for any machine lubrication problem. Find out about these automatic systems now. See for yourself the savings and efficiency they bring to your designs and you too will specify automatic Accumeter.




**Type O Accumeter Valves**

Meters .005 cubic inch of oil to rotary, oscillating, stationary—plain or anti-friction bearings. Up to 200 small bearings can be served by the single-line system equipped with these fixed output valves. Requires only 5/16" approximate turning radius.




**offers all these advantages!**

- Eliminates shutdown time for lubrication. Adds productive time to machine output
- Seals completely against dirt, grit, water all the way from "Barrel-to bearing"
- Prevents bearing troubles due to neglect or use of wrong lubricant
- Services all bearings—including those inaccessible or dangerous—in one operation
- Avoids work spoilage and bearing repairs due to over-lubrication

### factory tested—field proved

Exhaustive, in-the-field tests show no appreciable variation in the amount of lubricant discharged after 73,312 lubrication cycles—*equal to* 122 YEARS *of twice-a-day service!*

**ALEMITE**
REG. U. S. PAT. OFF.

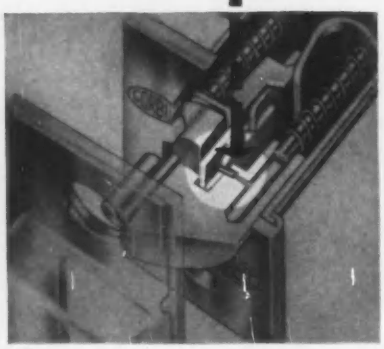
A PRODUCT OF SW STEWART WARNER

**Free**—*Alemite Accumeter Catalogue*

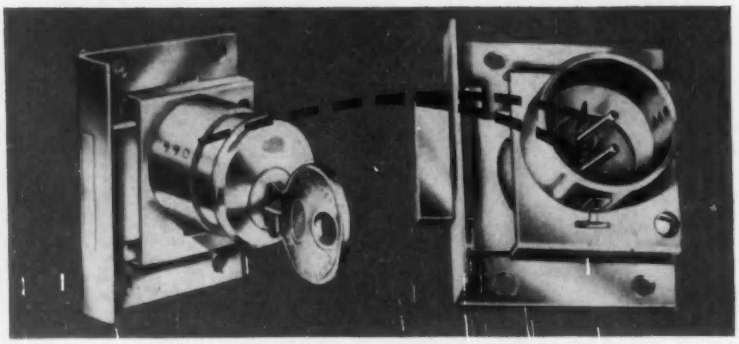
ALEMITE, DEPT. T-84
1850 Diversey Parkway, Chicago 14, Illinois
Please send me my free copy of the Alemite Accumeter Catalogue

Name_____
Company_____
Address_____
City_____ State_____

# SPIROL PIN's strength and radial tension improve two locks for American Hardware!

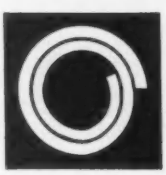


**1** New Corbin "Defender" lockset has latchbolt designed around hidden Spirol pin fastening. Pin holds in place with only 1/16" engaged at each end. Bolt tail rides on exposed 1/8" center portion of pin. Spirol's radial tension locks pin in place, prevents it riding into track of plunger bolt.



**2** Three interchangeable cylinders make the revolutionary new Corbin "Adapta-Lock" adjustable to six different thicknesses of wood or metal. Headed Spirol pins hold any of the cylinder plugs firmly in barrel, yet allow easy adjustment to 3 positions. Spirol pins were substituted for solid pins when tests on models proved that their unique coil construction not only locked them securely into the cam, but also gave them greater shear strength. Even at maximum depth where pins project only 9/32" into cylinder, Spirol pins hold rigid, assure perfect tumbler contacts.

The strength and tension characteristics of Spirol pins, which enabled American Hardware engineers to improve the design and performance of these locks, are only two of the many qualities that recommend Spirol pins to engineers. Controllable tension and shear strength allow these pins to meet a wide range of specifications. Since reaming and riveting operations are eliminated, the pins reduce cost, speed production. Standard Spirol pins are made from heat-treated strip steel in sizes ranging from 1/32" to 1/2" diameters, 1/8" to 4" lengths. Special materials and sizes available to your specifications. *Write for literature and free sample Spirol pins.*



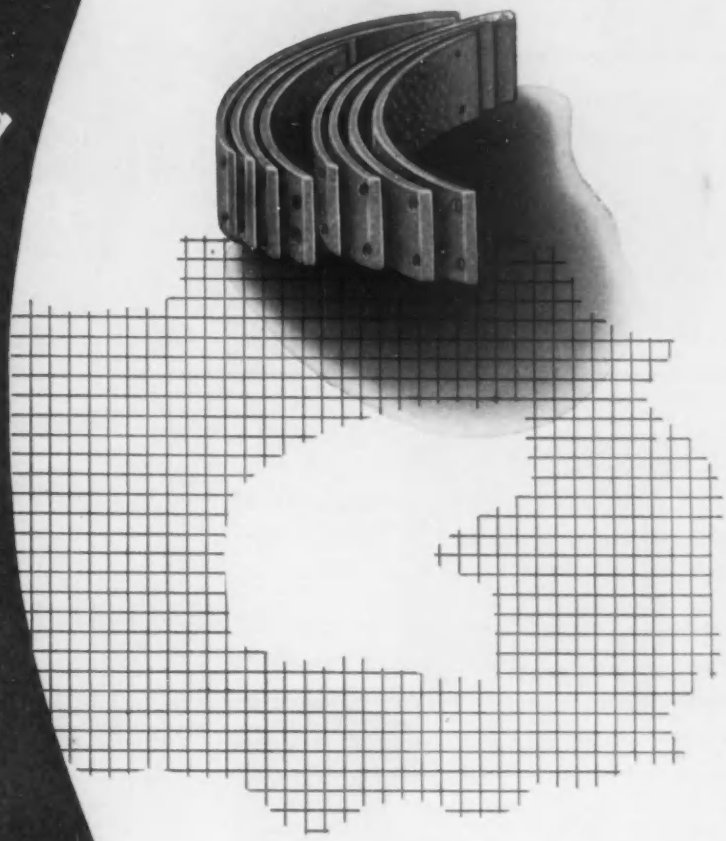
When compressed by insertion, Spirol pins exert even radial pressure, develop no weak "hinge" lines. "Live" action keeps pins locked tightly in hole, makes them dependable in fastening fragile plastic or heavy metal parts.

**SPIROL PIN**

U. S. and Foreign Patents Pending

**C. E. M. COMPANY • 76 SCHOOL STREET • DANIELSON, CONN.**

# Finding THE RIGHT WIRE CLOTH to fit YOUR PRODUCT



Finding the right wire cloth to fit precisely the job it has to do in your product means more than the right type and size of wire, or mesh, or type of weave. It must be right metallurgically—to fit into your fabrication processing. It must be right chemically—to fit, or combat, product-in-use conditions. If it is Reynolds wire cloth it will be *right*—precision processed to your specifications. Details in *Sweet's Product Design File* . . . or consult Reynolds Engineers without cost or obligation.

**Reynolds WIRE CLOTH for Industry**

NS NATIONAL-STANDARD Company NILES, MICHIGAN

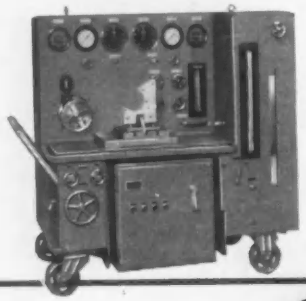
**REYNOLDS WIRE DIVISION,** NATIONAL-STANDARD CO., Box 200, **DIXON, ILL.**

*Divisions of National-Standard Co.*

**ATHENIA STEEL**...*Clifton, N. J.*.....Flat, High Carbon, Cold Rolled Spring Steel
**NATIONAL-STANDARD**...*Niles, Mich.*.....Tire Wire, Fabricated Braids and Tape
**WAGNER LITHO MACHINERY**...*Jersey City, N. J.*.....Metal Decorating Equipment
**WORCESTER WIRE WORKS**...*Worcester, Mass.*....Round and Shaped Steel Wire, Small Sizes

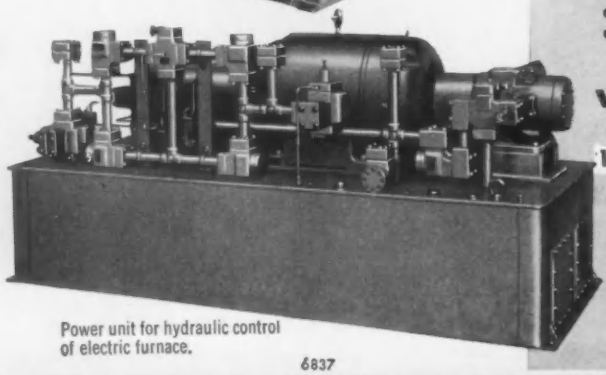
Pulpit type power unit provides full visibility, easy accessibility.

Compact power unit showing gasket-mounted valves.



Portable power unit for testing pumps.

Power unit with gasoline engine as prime mover.



Power unit for hydraulic control of electric furnace.

6837

**Individually Designed to Meet *SPECIFIC* Needs**

**VICKERS®**

***Custom Built***

# HYDRAULIC POWER UNITS

**DEPENDABLE PERFORMANCE**

**IMPROVE AND SIMPLIFY DESIGN**

**REDUCE INSTALLATION COST AND TIME**

**EASIER SERVICING**

**BETTER APPEARANCE**

**Vickers engineers approach the design of a custom-built hydraulic power unit from the standpoint of the customer's INDIVIDUAL needs. The sole objective is to meet HIS requirements with the best hydraulic "package". This assures the most compact, efficient and convenient hydraulic equipment for the particular machine.**

**A Vickers Hydraulic Power Unit includes all necessary pumps, valves, intermediate piping, oil reservoir, motors, controls, etc., as well as all hydraulic accessories (oil filters, air cleaners, oil level gauges, fittings, etc.). Hydraulic connections can be grouped in a convenient manifold.**

**In addition to the advantages mentioned above, each Unit is pretested at the factory and ready for immediate operation. Vickers undivided responsibility for the entire hydraulic control system is also an important feature to both the machine builder and his customer. Write for Bulletin 52-45.**

**VICKERS Incorporated**

*DIVISION OF THE SPERRY CORPORATION*

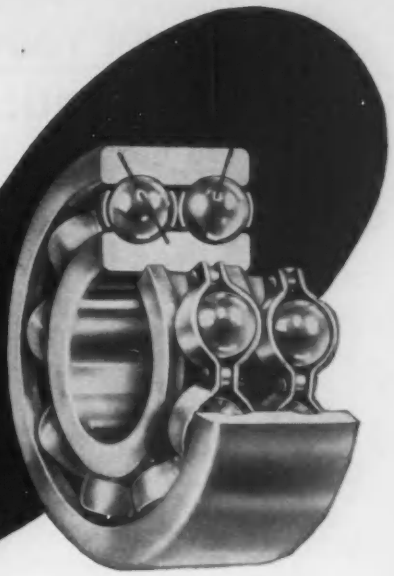
**1454 OAKMAN BLVD. • DETROIT 32, MICH.**

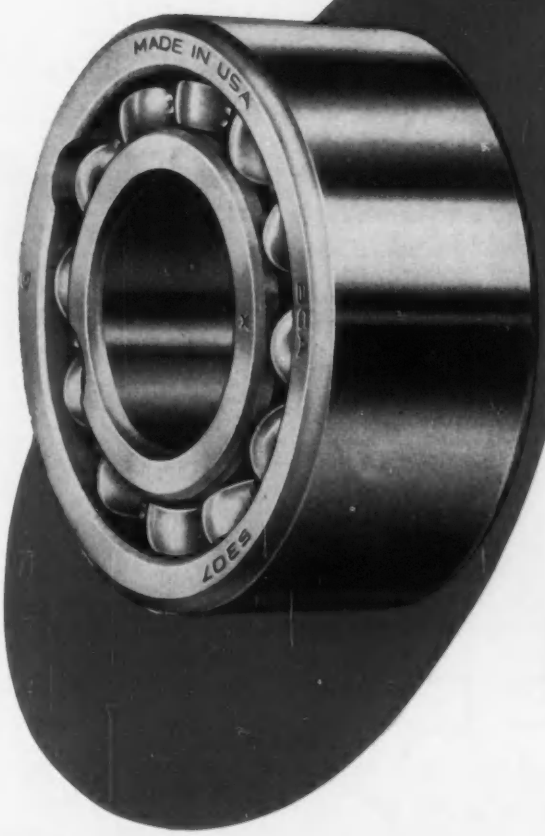
***Application Engineering Offices:*** **• ATLANTA • CHICAGO AREA (Brookfield) • CINCINNATI • CLEVELAND • DETROIT • HOUSTON LOS ANGELES AREA (El Segundo) • NEW YORK AREA (Summit, N.J.) PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) SEATTLE • TULSA • WASHINGTON • WORCESTER**

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

# BCA 5200 and 5300 SERIES BEARINGS

## can carry any combination of radial and thrust loads






These BCA double row bearings are of the Angular Contact, Maximum Capacity Type. The maximum load-carrying capacity is the result of the larger ball size in BCA design.

The vertex of the contact angle, between the balls and the raceways, falls within the bearing. This construction insures enough flexibility to compensate for mounting inaccuracies without sacrificing the rigidity required in many double row bearing applications.

BCA 5200 and 5300 Series Bearings can be furnished with shields and lock ring groove. Before specifying these added features, consult the BCA Engineering Department.

Complete data on these bearings is included among the valuable information in the BCA Engineering Handbook, which is available to chief engineers without charge. Write on your official stationery.

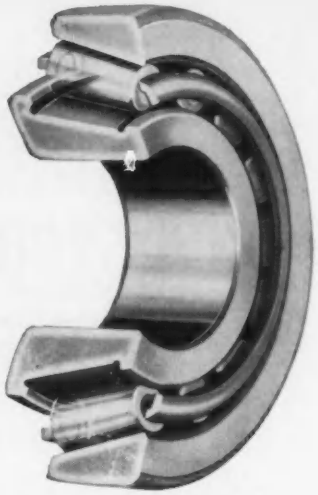
**BEARINGS COMPANY OF AMERICA**
*DIVISION OF FEDERAL-MOGUL CORP.*
**LANCASTER • PENNSYLVANIA**

**RADIAL, THRUST, ANGULAR-CONTACT BALL BEARINGS**

BCA

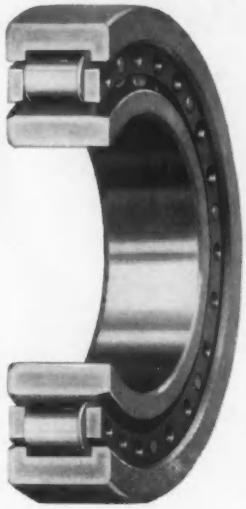
**WHATEVER YOUR ROLLER BEARING APPLICATION**

# specify BOWER!



Earthmovers, jet turbine engines, rolling mill equipment, truck axles—you name it! Bower builds a complete line of tapered, straight and journal roller bearings including a size and type to fit *your* product. What's more, these dependable bearings have *proved* themselves in virtually every conceivable type of application. Their built-in quality, skillful engineering and advanced design features provide such important bearing advantages as reduced wear, longer life and lower maintenance requirements. Let a Bower engineer give you full details on the complete Bower line.

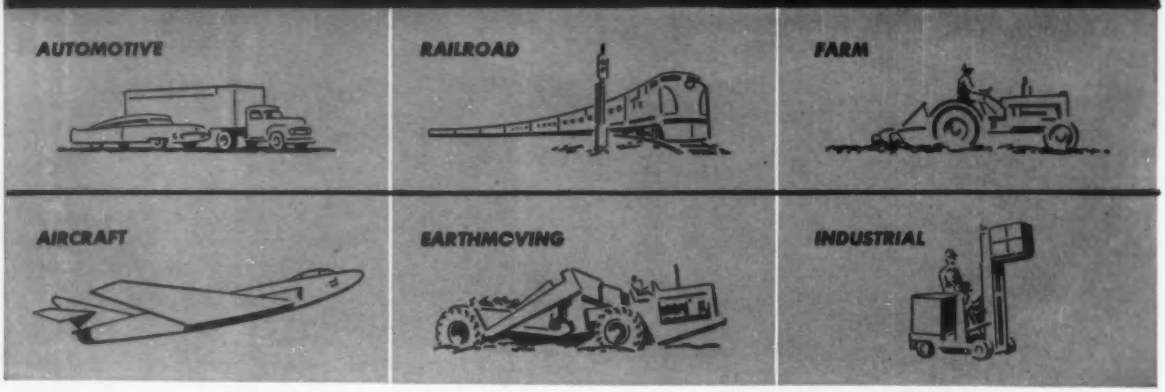
BOWER ROLLER BEARING COMPANY
DETROIT 14, MICHIGAN



***BOWER TAPERED ROLLER BEARINGS INCORPORATE ADVANCED SPHER-O-HONED DESIGN!*** Spherically generated roll heads and higher flange with larger, two-zone contact area reduce wear, improve roller alignment and virtually eliminate "end play." This helps hold adjustment and pre-load longer and better. Larger oil groove provides positive lubrication.

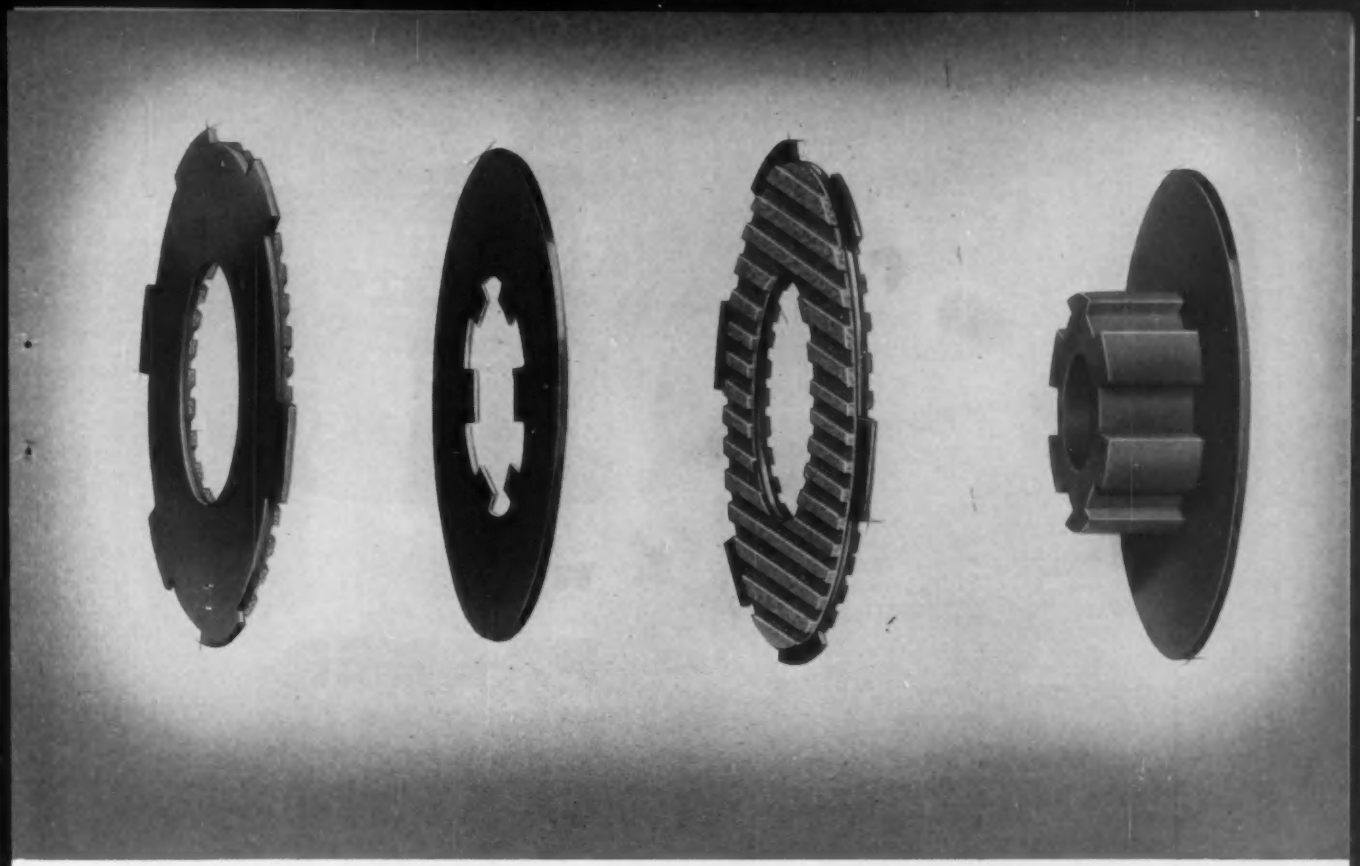
***BOWER STRAIGHT ROLLER BEARINGS ARE BUILT TO CARRY MAXIMUM LOADS!*** Integral two-lip race increases rigidity—keeps rollers in proper alignment at all times. Steel cage allows free movement of rollers between races during normal operation. High-grade alloy-steel rollers and races are precision-ground for quieter, smoother operation.

**A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS**
*for every field of transportation and industry*




BOWER
ROLLER BEARINGS

SPHER-O-HONED



**THREE CORK FACINGS** replaced *eight* other friction surfaces in this redesigned wet clutch. Performance was quieter, smoother. And service calls, due to clutch-plates, were eliminated—the cork facings last the life of the appliance.

## *CORK CLUTCH FACINGS:*

# dependable performance at low cost

Want to lower your costs and get consistently dependable clutch performance as well? Many manufacturers are finding that it pays to investigate the unique advantages of cork-compounded friction materials.

Cork's unusually high coefficient of friction normally makes it possible to use fewer or smaller plates in a wet clutch—or to reduce engagement pressures—and still maintain the desired torque capacity. And cork's resilience allows it to conform to opposing plates—makes surface finishing unnecessary.

Cork also lowers costs by giving more dependable performance. For example, a switch to cork facings enabled one appliance maker to virtually eliminate service calls due to faulty clutch operation. As first designed, this clutch used eight friction surfaces and required a half-hour run-in plus an oil drain-refill operation before installation. Even with this precaution, metal particles continue to damage gears and facings and cause clutches to fail.

By changing to cork facings, with their high torque capacity, the manufacturer reduced the number of friction surfaces from eight to three. Pre-installation run-ins are no longer necessary. In addition, the resilient cork surfaces give smoother, quieter operation. Best of all, the clutch facings now last the life of the appliance, eliminating annoying and expensive field maintenance.

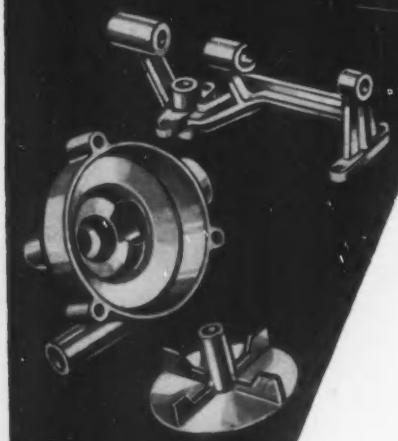
Whatever your application—appliance, automotive, business machine, or industrial equipment, there's a good chance that cork's low-cost, dependable performance can help you. We'll be glad to help you choose the most efficient cork facing for your use. Write Armstrong Cork Company, Industrial Division, 7208 Irvin Street, Lancaster, Pennsylvania.

## ARMSTRONG'S FRICTION MATERIALS

BLACKSTONE CORPORATION

## Reduces Weight and Cost

## with PARKER DIE CASTINGS



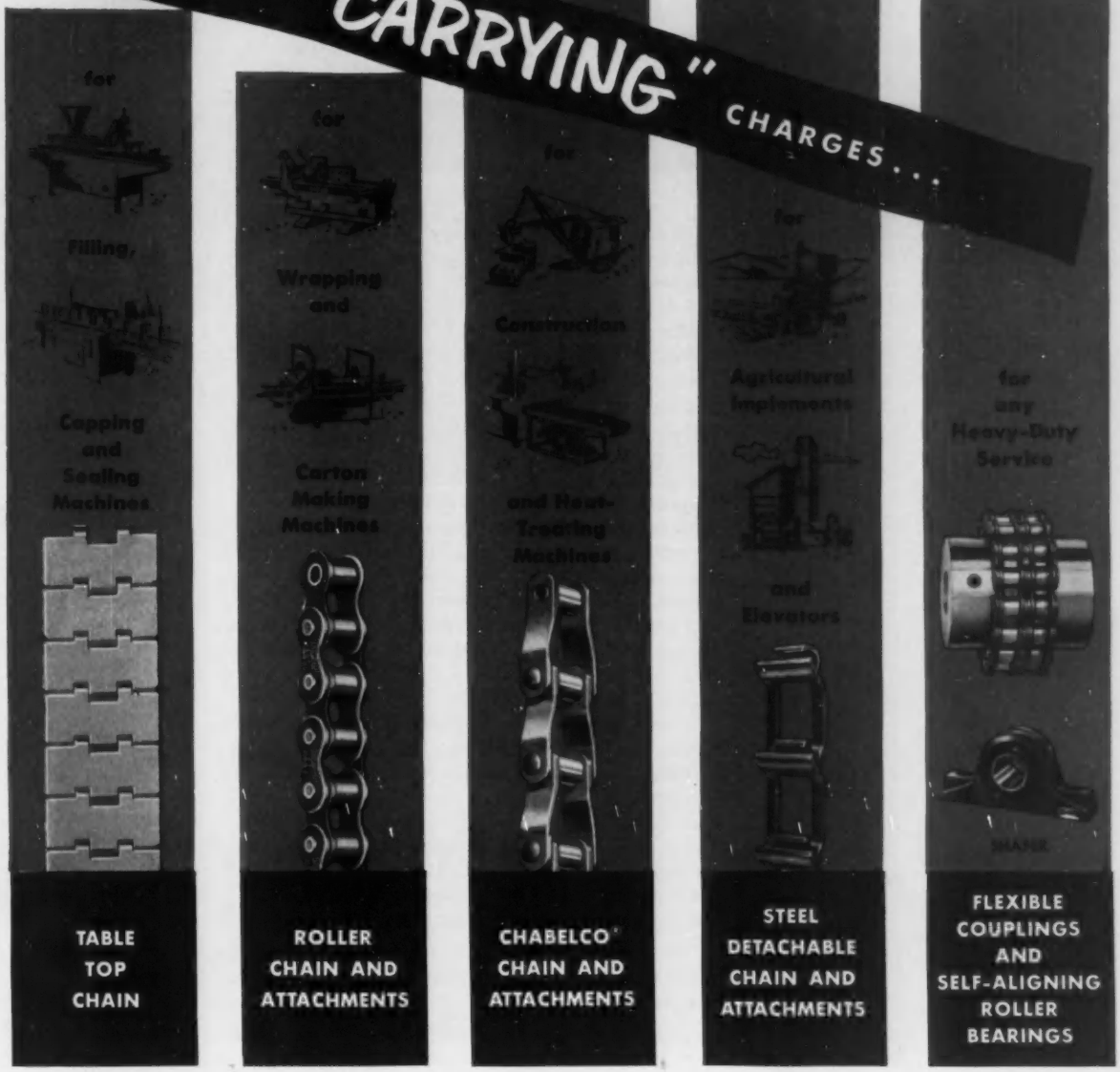
BLACKSTONE'S Full-Automatic Washer with the new flexible cycle is a distinct improvement over previous types. Today's housewife knows new leisure because of Blackstone's advanced engineering and design. For instance, the three parts shown here are Parker Die Castings. Costs are lowered since machining is virtually eliminated. Weight has been reduced without loss of strength. Parker Die Castings are in use in nearly every industry—cast to exacting alloy and design specifications by experienced Parker craftsmen. Call on Parker engineers the next time you need die castings. Each of us will profit.

*and when you think of Die Castings* THINK OF

Parker White Metal Company • 2153 McKinley Ave., Erie, Pa.

# PARKER ALUMINUM *and* ZINC *Die Castings*

# TO CUT "CARRYING" CHARGES...




For any cost-reduction or product-improvement program that involves the movement of material through a machine, there is a size and type of Chain Belt Chain and Attachment that can help you. From the complete line, your Chain Belt District Sales Engineer will be happy to assist you in your drive or conveyor chain, sprockets, flexible couplings and self-aligning roller bearing selections. He has a broad background of experience in conveying and power transmission . . . can help you cut your "carrying" charges! Call your Chain Belt Sales Engineer or mail the coupon today.

*Always* **the one best chain for each service**

**CHAIN BELT COMPANY**

**District Sales Offices in all Principal Cities**

CHAIN BELT COMPANY 54-502
4715 W. Greenfield Ave.,
Milwaukee 1, Wis.

I am designing a.....

.....

.....

☐ Send literature on: ☐ TableTop; ☐ Roller Chains; ☐ Chabelco Chains; ☐ Detachable Chains; ☐ Couplings; ☐ Bearings; ☐ Sprockets.
☐ Have my Chain Belt Man call.

*Name*.....

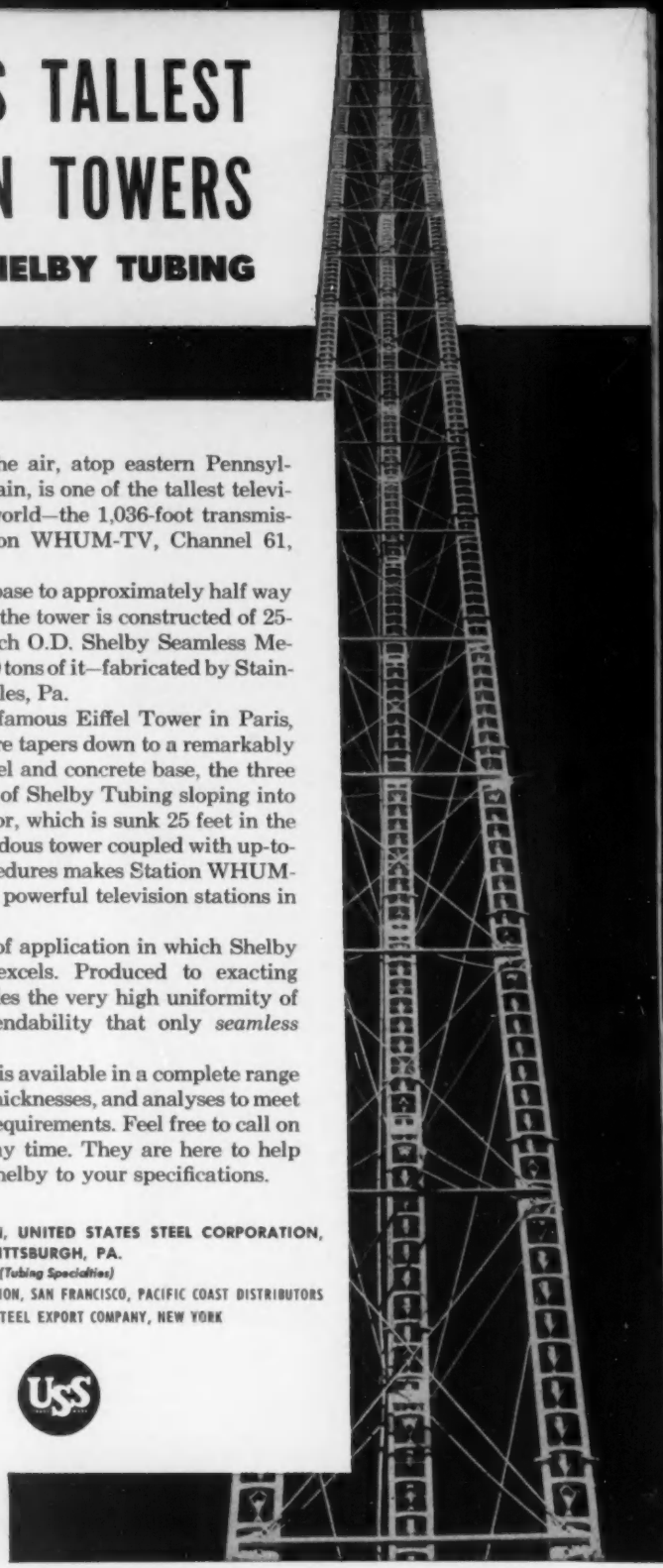
*Company*.....

*Address*.....

*City*.....*Zone*...*State*.....

# ONE OF THE WORLD'S TALLEST TELEVISION TOWERS

## RESTS ON 50 TONS OF SHELBY TUBING



• Rising high in the air, atop eastern Pennsylvania's Blue Mountain, is one of the tallest television towers in the world—the 1,036-foot transmission tower of Station WHUM-TV, Channel 61, Reading.

From its tapered base to approximately half way up—about 500 feet—the tower is constructed of 25-foot sections of 4-inch O.D. Shelby Seamless Mechanical Tubing—50 tons of it—fabricated by Stainless, Inc., North Wales, Pa.

Higher than the famous Eiffel Tower in Paris, the gigantic structure tapers down to a remarkably small triangular steel and concrete base, the three supporting sections of Shelby Tubing sloping into their concrete anchor, which is sunk 25 feet in the ground. The tremendous tower coupled with up-to-date television procedures makes Station WHUM-TV one of the most powerful television stations in the world.

This is the type of application in which Shelby Seamless Tubing excels. Produced to exacting standards, it provides the very high uniformity of strength, and dependability that only *seamless* tubing can give.

Shelby Seamless is available in a complete range of diameters, wall thicknesses, and analyses to meet the most exacting requirements. Feel free to call on our engineers at any time. They are here to help you apply U·S·S Shelby to your specifications.

**NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.**
*(Tubing Specialties)*
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

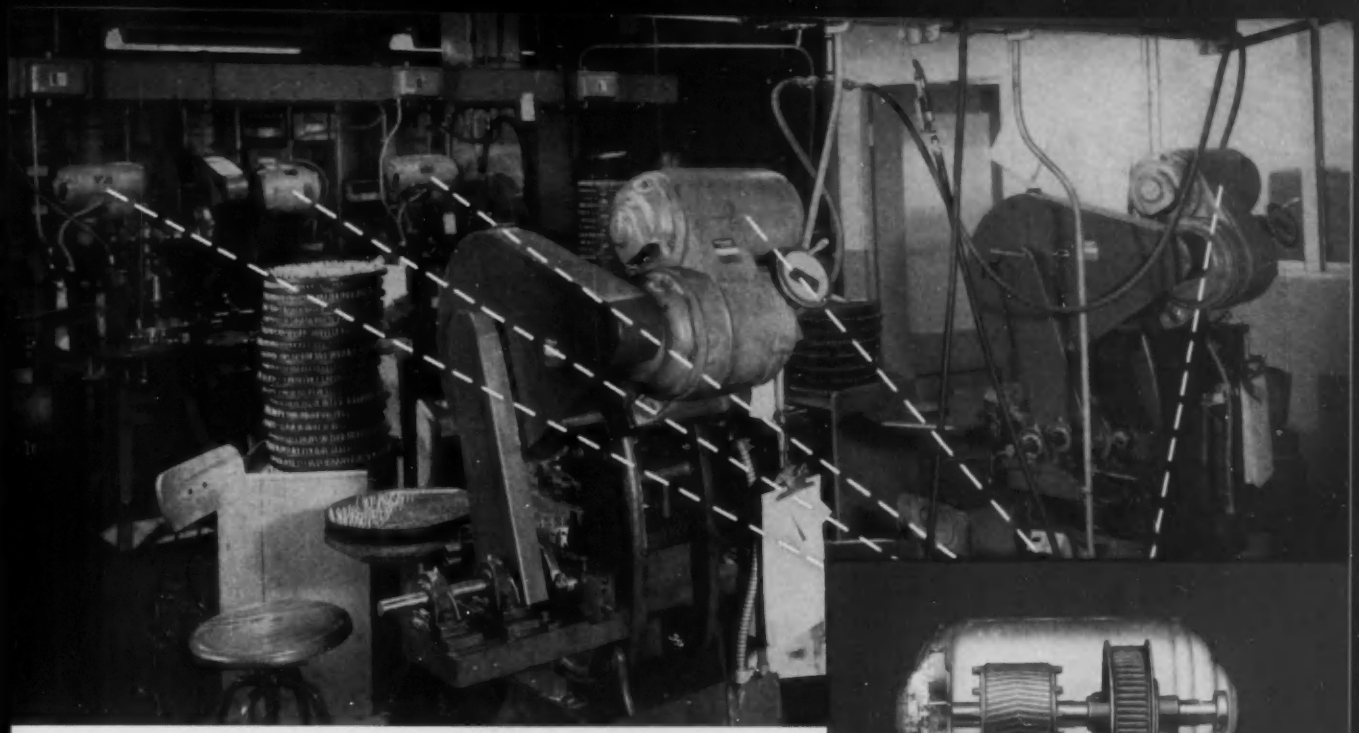
WALLS WITHOUT WELDS

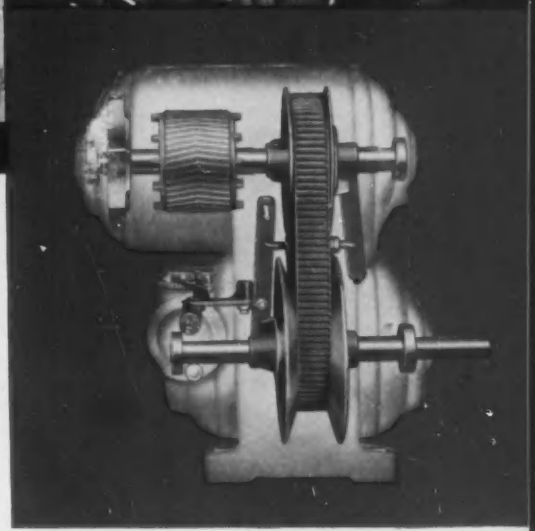
**THE TOWER WAS ERECTED** in 25-foot sections—each section alternately painted red and white. In an average 8-hour work day, the crew completed ten sections.

**TRANSMISSION TOWER,** Station WHUM-TV Reading. Steel guy wires, 1¼ inch dia., are attached to the tower at consecutive 175-foot levels, and are anchored in concrete 400 feet and 800 feet from the structure in all directions. Aircraft warning lights are also located at 175-foot levels.

## U·S·S SHELBY SEAMLESS MECHANICAL TUBING

UNITED STATES STEEL





## CHERRY RIVET CO. INCREASED PRODUCTION, CUT COSTS WITH SPEED-TROLS

Sterling Speed-Trols are aiding in faster, more economical production of our patented Cherry Blind Rivet, reports Mr. Milo Ketchum, Chief Engineer of Cherry Rivet Company, Los Angeles. Speed-Trols were selected to drive our specially designed automatic upsetting machines because of their accurate speed selection, positive pulley adjustment, compactness, smooth, quiet operation. We have used Speed-Trols for over five years without one bit of repair cost.

# Speed-Trol...Variable Speed at its Best

### OUTSTANDING FEATURES:

**A Single, Compact Power Unit** containing motor, variable speed transmission, with or without integral speed reducer—**Effective Cooling Systems** with direct-through ventilation, dual or internal cooling—**Positive Pulley Adjustment** for infinite speed variation, accurate speed selection and regulation—**Fingertip Control of Speed** with standard or remote controls—**Specially Designed V-Belt** for heavy duty, long life—**Protected Designs,** drip-proof, splash-proof, totally enclosed—**Rugged Construction** for continuous duty, permanent bearing alignment—**Streamlined** for easy cleaning, better appearance—**Interchangeable Mounting Dimensions** between constant and variable speed drives—**Versatile Mounting** for any position—**Smooth, Quiet Operation** through dynamic balancing; Herringbone Rotor; pre-lubricated, double shielded ball bearings—**Low Installation Cost** due to compact design, versatile mounting, interchangeable mounting dimensions.

**20-PAGE ILLUSTRATED CATALOG** ... Sterling Speed-Trol, Slo-Speed, Klosd and Klosd-Tite Electric Power Drives. Write for catalog H-431.

***There is a Sterling Electric Power Drive to Meet Virtually Every Requirement***

Sterling Slo-Speed Electric Power Drives—for geared low speed at its best
Sterling Klosd and Klosd-Tite Motors—for constant normal speed at its best

# STERLING ELECTRIC MOTORS

Plants: New York City 51 • Chicago 35 • Los Angeles 22 • Hamilton, Canada • Santiago, Chile
Offices and distributors in all principal cities

## Here's Enduro Stainless Steel Quality for only 9% more cost

That's the experience of the Guardian Locker Division of The Flxible Company, Millersburg, Ohio. They're making and selling public rental lockers. They use ENDURO Stainless Steel for all exterior sections, and for interior bottom sections —at the place where wear is heaviest. They're making coin receivers and lock parts of ENDURO, too.

*Cost is only 9% more than it would be for the same locker made of plain carbon steel, painted.* Revenue increases from the stainless steel lockers are reported to range from 15% to 40%.

Women particularly are attracted by the bright, clean-looking ENDURO finish. It has a psychological "sell". And, ENDURO naturally is easier to maintain. Easy to keep clean and bright looking. ENDURO will not tarnish. It resists abrasion and denting. It has no applied surface to chip, peel, or wear away. It lasts long. It is easy to fabricate.

Here's more proof that ENDURO brightwork sells. That it appeals to everyone. It can do the same for your products. Republic metallurgists will help you apply ENDURO's "bonus benefits" to step up interest and sales power . . . efficiently and economically. Just write:

**REPUBLIC STEEL CORPORATION**
*Alloy Steel Division • Massillon, Ohio*
**GENERAL OFFICES • CLEVELAND 1, OHIO**
Export Department: Chrysler Building, New York 17, N. Y.

**REPUBLIC ENDURO STAINLESS STEEL**

REPUBLIC STEEL



UNITED STATES STEEL

# High speed spindle gets greater accuracy with TIMKEN® bearings in new semi-flexible mounting

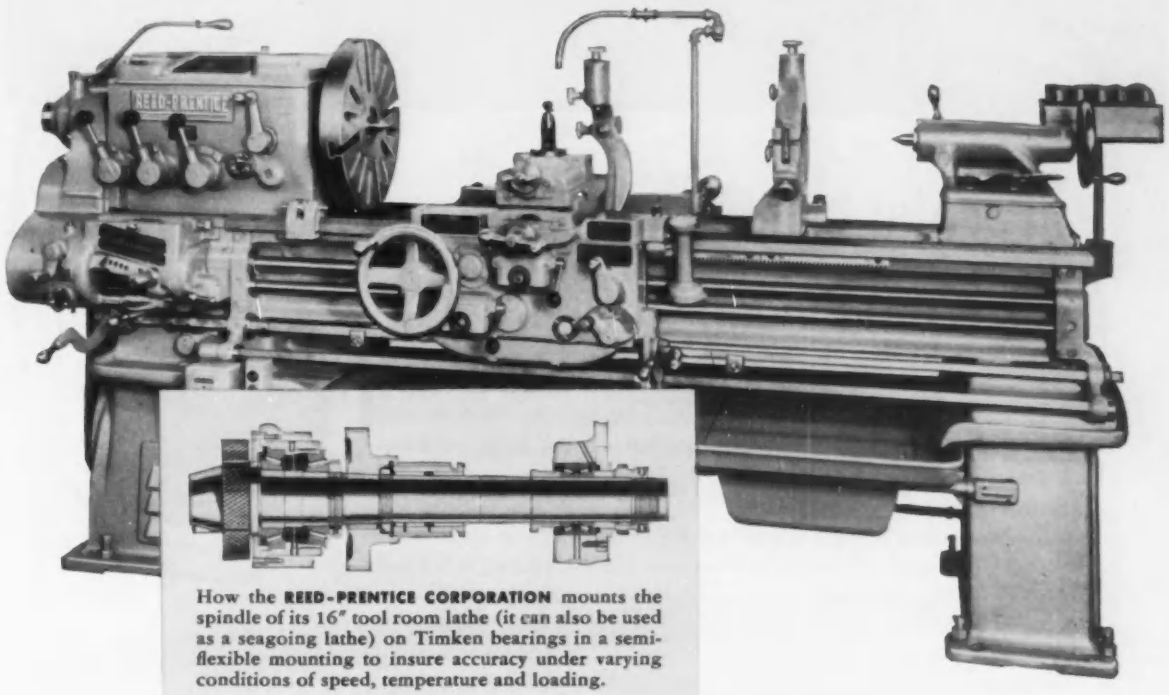
REGARDLESS of varying conditions of speed, temperature and loading, the high-speed spindle on the Reed-Prentice Corporation's 16″ tool room lathe retains extreme accuracy. The reason: The spindle is mounted on Timken® tapered roller bearings in a new semi-flexible mounting. This application was found so successful on the 16″ lathe that it is now being adopted for Reed-Prentice's 20″ lathe.

In this semi-flexible mounting, the innermost of the two front spindle bearings is mounted in a cup carrier. One end of the carrier has a slight radial clearance in the housing while the other end has a tight fit. The clearance between carrier and housing permits radial expansion without excessive preloading of the bearing. As a result, from the beginning to the end of every job, uniformly high spindle precision is maintained.

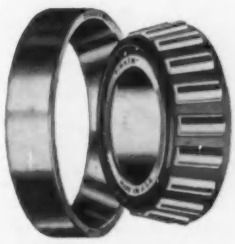
Timken precision bearings are especially designed for spindle applications. Their tapered construction lets them take radial and thrust loads in any combination, holds spindle rigid, permits pre-loading to any desired degree to prevent chatter.

Next time you buy or build a machine tool, make sure it's Timken bearing equipped. Timken bearings practically eliminate friction, give longer life with less maintenance. Always look for the trademark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

*This symbol on a product means its bearings are the best.*



How the **REED-PRENTICE CORPORATION** mounts the spindle of its 16″ tool room lathe (it can also be used as a seagoing lathe) on Timken bearings in a semi-flexible mounting to insure accuracy under varying conditions of speed, temperature and loading.



**TIMKEN**

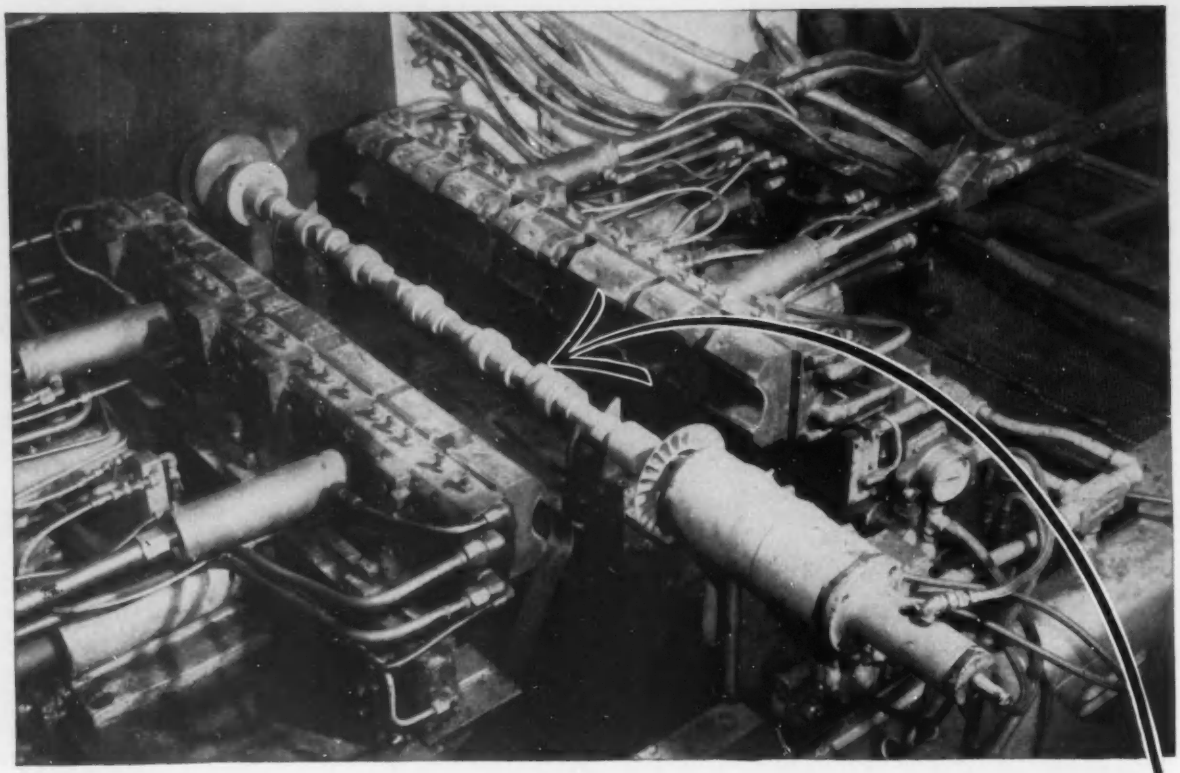
TRADE-MARK REG. U. S. PAT. OFF.

***TAPERED ROLLER BEARINGS***

**MAGNIFYING GLASS INSPECTION OF EVERY ROLLER!**

Every one of the over one billion Timken bearing rollers produced every year is inspected with powerful magnifying glasses to detect surface flaws. It's just one example of how the Timken Company insures uniform high quality.

**NOT JUST A BALL ◯ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ▯ AND THRUST ←▯→ LOADS OR ANY COMBINATION**

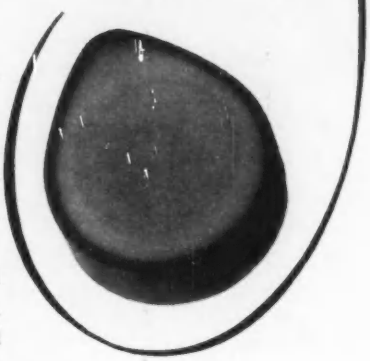


# Automatic Flame-Hardening Boosts Production 300%

Using an automatic oxy-acetylene flame-hardening machine, a leading manufacturer of trucks and marine equipment increased the production of flame-hardened gears, bearings, and camshafts 300 per cent. Parts are flame-hardened on as many as 22 different surfaces in fast, simple operations.

The flame-hardening process produces wear-resistant surfaces on large and small sections without heating the entire part . . . Distortion is at a minimum, and case depth is easily and accurately controlled. Flame-hardening is fast and relatively simple compared with other methods of hardening metal such as nitriding and carburizing. Low cost, portable flame-hardening equipment is available for the majority of applications.

Your local LINDE representative will be glad to show you how to produce machine parts with a tough, ductile interior and a hard, wear-resistant surface. Start saving now, call him for more information on flame-hardening.



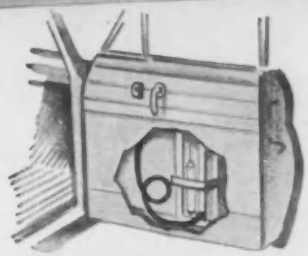
A cross-section view of this camshaft shows an even, uniform depth of the hardened surface.

**LINDE AIR PRODUCTS COMPANY**
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: DOMINION OXYGEN COMPANY
Division of Union Carbide Canada Limited, Toronto

Linde
Trade-Mark

"Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.

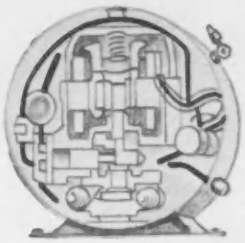
**FROM** *the Bundy Sketchbook*
**TO** *jog a designer's imagination*



AUTOMOTIVE HYDRAULIC WINDOW LIFT LINES

FRAME FOR OCCASIONAL TABLE

REFRIGERATOR COMPRESSOR LINES



**REMARKS** Do you have a tubing design that won't jell -- or a fabrication kink you can't untangle? Whatever your tubing headache, why not turn it over to our engineering experts. They offer you years of problem-solving experience, plus the added bonus of Bundyweld, the only tubing double-walled from a single strip (see below).

**WRITE** today for catalog or for help in developing your tubing ideas.

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN

SUPERMARKET PUSHCART FRAME

## WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness,

and passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

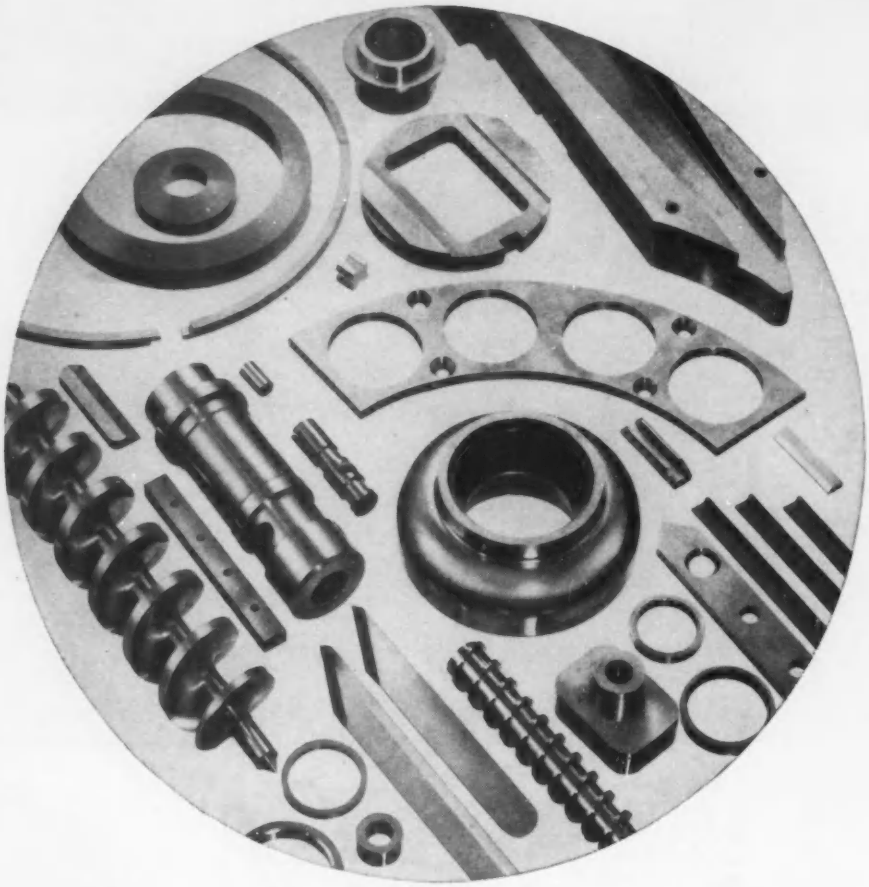
# BUNDYWELD TUBING®

**DOUBLE-WALLED FROM A SINGLE STRIP**

**Leakproof**
**High thermal conductivity**
**High bursting point**
**High endurance limit**
**Extra-strong**
**Shock-resistant**
**Ductile**

**Lightweight**
**Machines easily**
**Takes plastic coating**
**Takes plating**
**Bright and clean**
**No inside bead**
**Uniform I.D., O.D.**

**Bundy Tubing Distributors and Representatives:** ***Bridgeport, Conn.:*** Korhumel Steel & Aluminum Co., 117 E. Washington St. • ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Los Angeles 58, Calif.:*** Tubesales, 5400 Alcoa Ave. • ***Philadelphia 3, Penn.:*** Ritan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South • ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E.
**Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.**



*Some typical parts produced from* HAYNES *alloys*

# Custom Tailored to cut maintenance costs

## *Alloys for Every Wear Condition Shaped to Your Specifications*

HAYNES alloys are available in a wide range of properties. They can be supplied as castings, forgings, stampings, or fabricated parts finished to close tolerances and with a mirror-like finish where required.

Some HAYNES alloys are extremely hard—to resist severe abrasion. Some are tough and ductile, designed for use where mechanical shock or repeated stress cause ordinary metal parts to crack and splinter. Some resist the corrosive action of acids, alkalies, and molten metals. Erosion from steam or liquids, the softening effects of high-temperatures, seizing and galling from metal to metal contact, are other severe conditions that can be effectively controlled through the use of HAYNES alloys.

Send us a blueprint of one of your wearing parts and tell us about the conditions under which the part must operate. We are sure we can supply you with a HAYNES alloy part "custom tailored" to solve your problem.

"Haynes" is a registered trade-mark of
Union Carbide and Carbon Corporation.

HAYNES TRADE-MARK ALLOYS

**HAYNES STELLITE COMPANY**

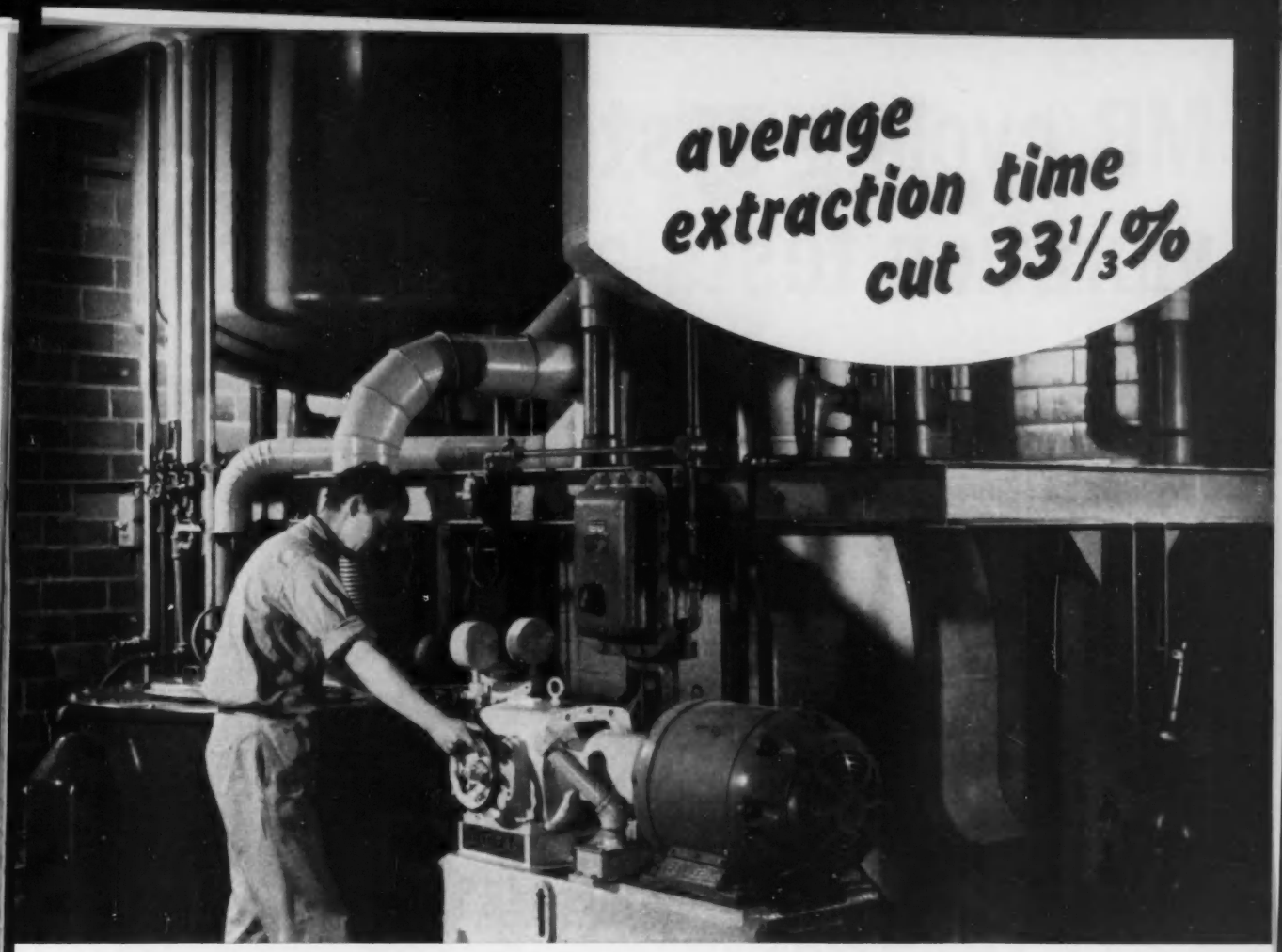
**A Division of Union Carbide and Carbon Corporation**

UCC

General Offices and Works, Kokomo, Indiana

Sales Offices

Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa




# Once more the ANY-SPEED Oilgear Drive betters machine performance "painlessly"

Many times in our experience the performance of an already highly efficient machine has been bettered without redesign, solely by changing the drive. One case out of many *varied* cases, is the Tolhurst Centrifugal pictured above, located in a great pharmaceutical house. This centrifugal was originally equipped with a two-speed electric motor drive. However the chemicals it is called upon to handle have widely varying crystal packing characteristics. Some of these crystals packed so densely at the speed available, extraction was inhibited, extraction time far out of balance and crystal removal difficult.

A change was made to an *"ANY-SPEED"* Oilgear Fluid Power Drive. Now the operator is able to shade the speed of the centrifuge experimentally—*and easily discover* the *best* speed for each batch of crystals.

As a result, extracting that used to take from 6 to 9 hours was cut to 4 to 6 hours. The extremely slow speed also available made unloading a great deal easier. This user now has several other Oilgear drives including one on a laboratory centrifuge.

There is very often a direct efficiency coefficient between machine operating speed and the type of work being handled. And we can cite many widely varying instances where equally dramatic and profitable gains resulted at once from a simple change to *"ANY-SPEED"* Oilgear Fluid Power Drives. If you want some interesting factual data on Oilgear's steplessly variable speed drives, their outstanding responsiveness to control impulses, their smooth acceleration and deceleration, talk to an Oilgear Engineering Representative. His mature and sound engineering recommendations may profit you greatly. THE OILGEAR COMPANY, 1571 W. Pierce St., Milwaukee 4, Wisconsin.

OILGEAR

**OILGEAR**

# MB cycling system runs vibration tests automatically

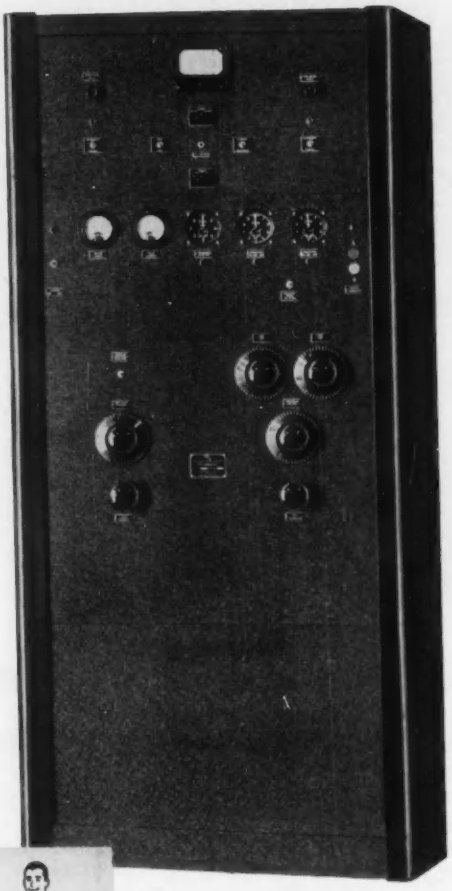
***Versatile electronic "brain" for MB Vibration Exciters saves manpower and manhours—performs a variety of cycled shake-tests unattended!***

A vibration test that involves a continuous cycle of changes from 10 to 500 cps along with constant displacement or constant acceleration can now be done with great simplicity, accuracy and minimum supervision. Simply set up the specimen on an MB Shaker—set the controls for the desired actions—and let the cycling system take over.

This electronic unit varies shaker frequency at any sweep speed, and between any two preset frequency limits. It controls the exciter's amplitude or acceleration within ±10% for a dead mass or resonant type of loading and for cycled tests to satisfy MIL-E-5272 and other specifications.

For maximum flexibility of operation, this cycling system also provides for automatic transfer of constant amplitude to constant "g" at any preselected frequency setting.

The system can be operated manually when desired. It's also protected against control failure or conditions of extreme load resonances through use of an automatic structural strain control.



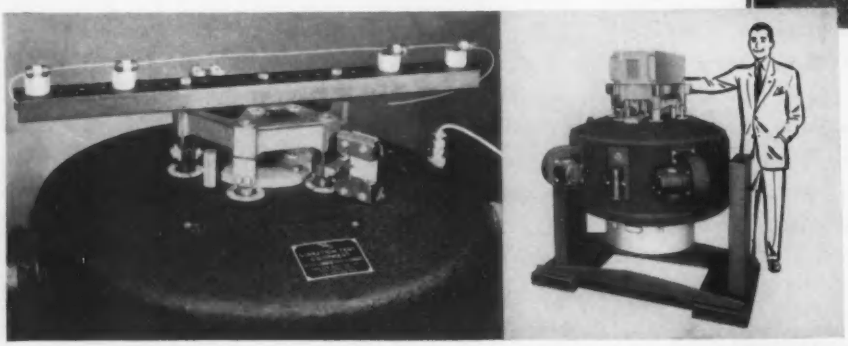
**MB MODEL T-25 MC CONTROL CABINET** with automatic cycling system developed to control the action of vibration exciters to a specified cycle of events, and with little or no supervision.

### SHAKE TESTING PAYS

Vibration testing tells how well a product will bear up in service, reveals design faults, determines fatigue strength.

Designed for heavy duty service, MB vibration exciters such as the Model C-5, rated at 750 pounds force, and the Model C-25 rated at 3500 pounds force, deliver maximum performance, pure table motion and dependable operation.

Send for detailed specifications on MB cycling systems. Also for Bulletin which gives data on vibration exciters.



**A VIBRATION TEST** set up on the Model C-5 MB Vibration Exciter—and also one on Model C-25—two of the models which can be automatically controlled by MB's cycling systems.

**THE MB MANUFACTURING COMPANY, INC.**
1060 STATE STREET, NEW HAVEN 11, CONN.

**BULLETIN TELLS MORE**
Contains specifications, operating information and helpful hints on usages of the complete line of MB Exciters. Write for Bulletin 1-VE-5.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO GENERATE IT

# MORE POWER IN SMALLER FRAMES

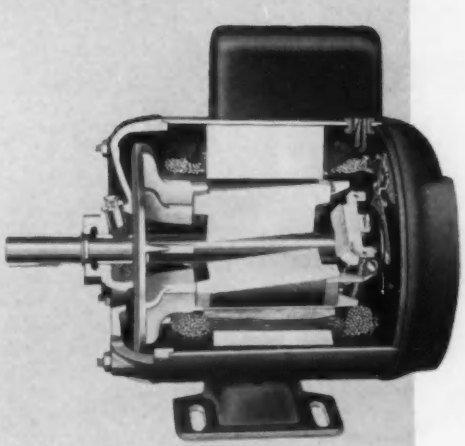
SAVE SPACE

WEIGH LESS

# NEW Century Form "F" Fractional H.P. Motors

**NOW AVAILABLE IN ⅛ TO ¾ H.P.**

**Thanks to new techniques developed in the last several years, this *smaller* power package combines improved performance with even greater Century dependability.**



## Here's What New Techniques Deliver...

1. Better magnetic characteristics for the motor because of more uniform silicon laminated steel in magnetic cores.
2. A high dielectric and increased abrasive resistance qualities result from improved plastic insulated wire in the coils.
3. Important slot space is saved by improved plastic slot insulation. Extremely tough with higher dielectric resistance.
4. Unusual resistance to abrasion, moisture and heat is provided by improved thermal setting plastic varnish insulation on windings.
5. Squirrel cage rotors are more uniform because of improved high-pressure die-cast aluminum rotors. Individually, dynamically balanced.
6. Increased cooling ability is provided by improved ventilation.
7. These new Century Motors incorporate all mechanical features proved effective in thousands of varying applications.

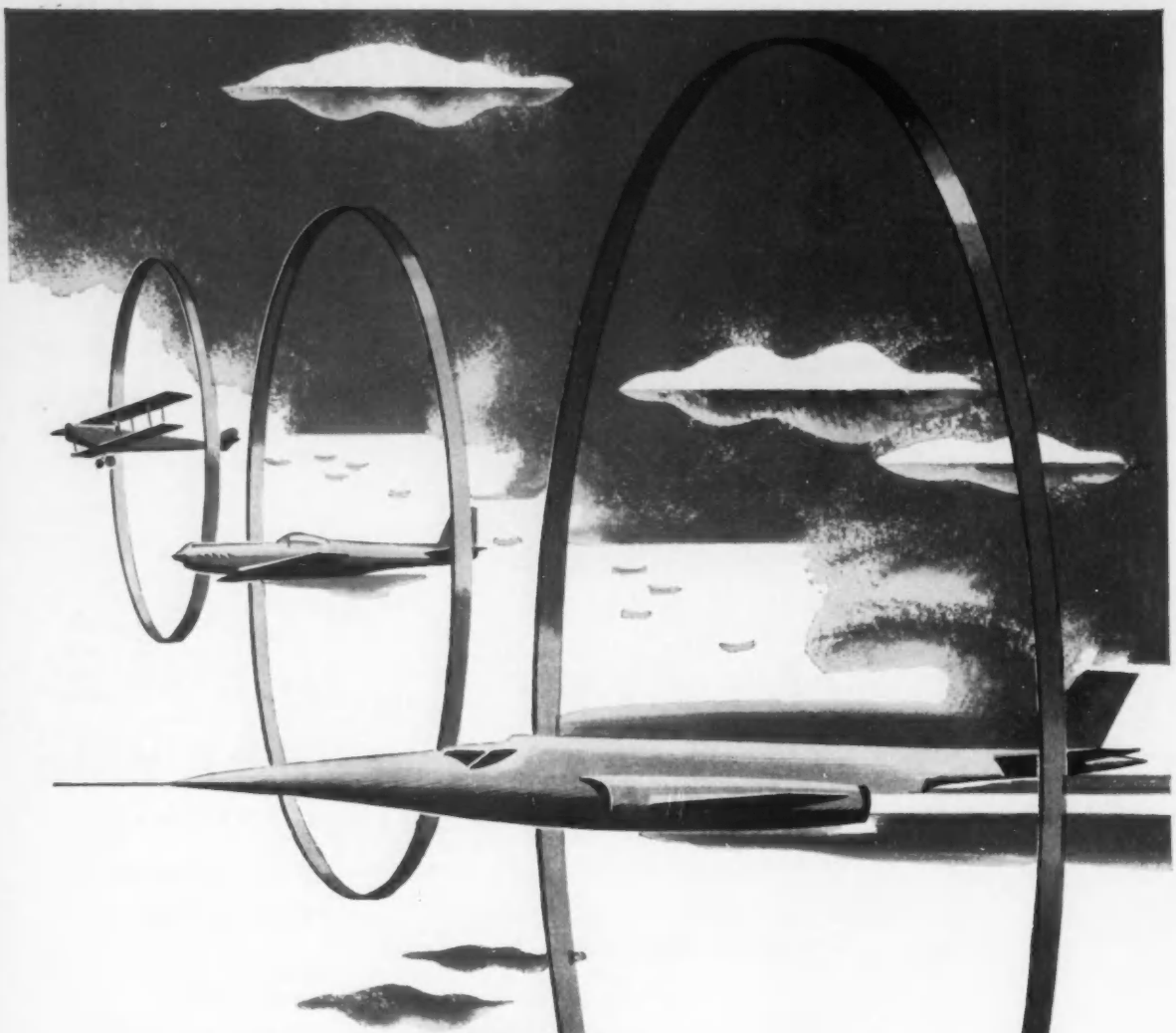
*For full details on Century Fractional H. P. Motors—write for bulletin 1-S Page 1. Century also offers a wide range of types and sizes in AC and DC . . . 1/8 to 400 H. P.*

Century C MOTORS

**CENTURY ELECTRIC COMPANY,** 1806 Pine Street, St. Louis 3, Missouri

*Offices and Stock Points in Principal Cities*

832



# The shape of rings to come

It is difficult to predict the shape tomorrow's air power will take. But one thing is certain — fabrication of many of the component parts, such as rings, bands, and the complicated assemblies will be accomplished by welding.

If a new alloy — a special metal — an intricate assembly pose a problem to design or manufacture perhaps our specialized knowledge gained in 35 years of welding fabrication can help to find a practical and economical solution. Our Product Development Division will be glad to put experience gained from working with every major U. S. jet engine manufacturer to work for you. In addition to fusion and resistance welding of ferrous and non-ferrous metals, American Welding can provide designing, engineering, metallurgical and machining facilities.

*Write us today for complete details*
*140 Dietz Road • Warren, Ohio*

THE AMERICAN WELDING & MANUFACTURING COMPANY • WARREN • OHIO

# ANACONDA METALS AT WORK

**A special alloy wire goes into the G-E SLEEP-GUARD Blanket ... sheet brass into the Westinghouse Thermometer Set ... and Everdur Copper-Silicon Alloys into the Sherwood Valve.**

## Shut-eye's safer with new shut-off control

Ahhh, sleep... it's wonderful! And now because of G. E.'s new SLEEP-GUARD Wiring System—made of two spiral wires separated by a nylon sheath—sleep's safer, too. If the heating wire becomes too warm, the nylon sheath—along with the heater and signal wire—automatically turns off your blanket. Both wires are made of Hitenso*, a cadmium bronze which provides just the right electrical and mechanical properties. We process almost 100 copper alloys into wire in a wide variety of sizes and shapes, tempers and finishes.

## A million at one clip for Betty

Anyone who's ever settled down before a TV set needs no introduction to charming Betty Furness of Westinghouse Studio One fame. Betty's currently offering her vast viewing audience this handy Westinghouse Kitchen Thermometer Set at a bargain price. And Westinghouse expects an overwhelming response. That's why they had Chaney Mfg. Co., Springfield, Ohio, make a million of these sets at one clip. And speaking of clips, those attached to these thermometers are made of coiled brass strip in the most economical alloy, gage and temper.

## Vive le valve plug!

The Aluminum and Brass Co., Lockport, N. Y., calls this valve plug—which employs a nylon insert and operates under pressures up to 3,000 psi—the "heart" of their Sherwood Oxygen Valve. We're mighty proud about their enthusiasm, since the plug is made of one of our Copper-Silicon Alloys. Everdur*-1015 was chosen because roll-threading not only frees it from burrs but also work-hardens its surface, making it less likely to wear, gall or "freeze." Everdur-1015's cold-working properties also allow it to be rolled *over* the nylon insert. A tight "cap" results.

## Want more information?

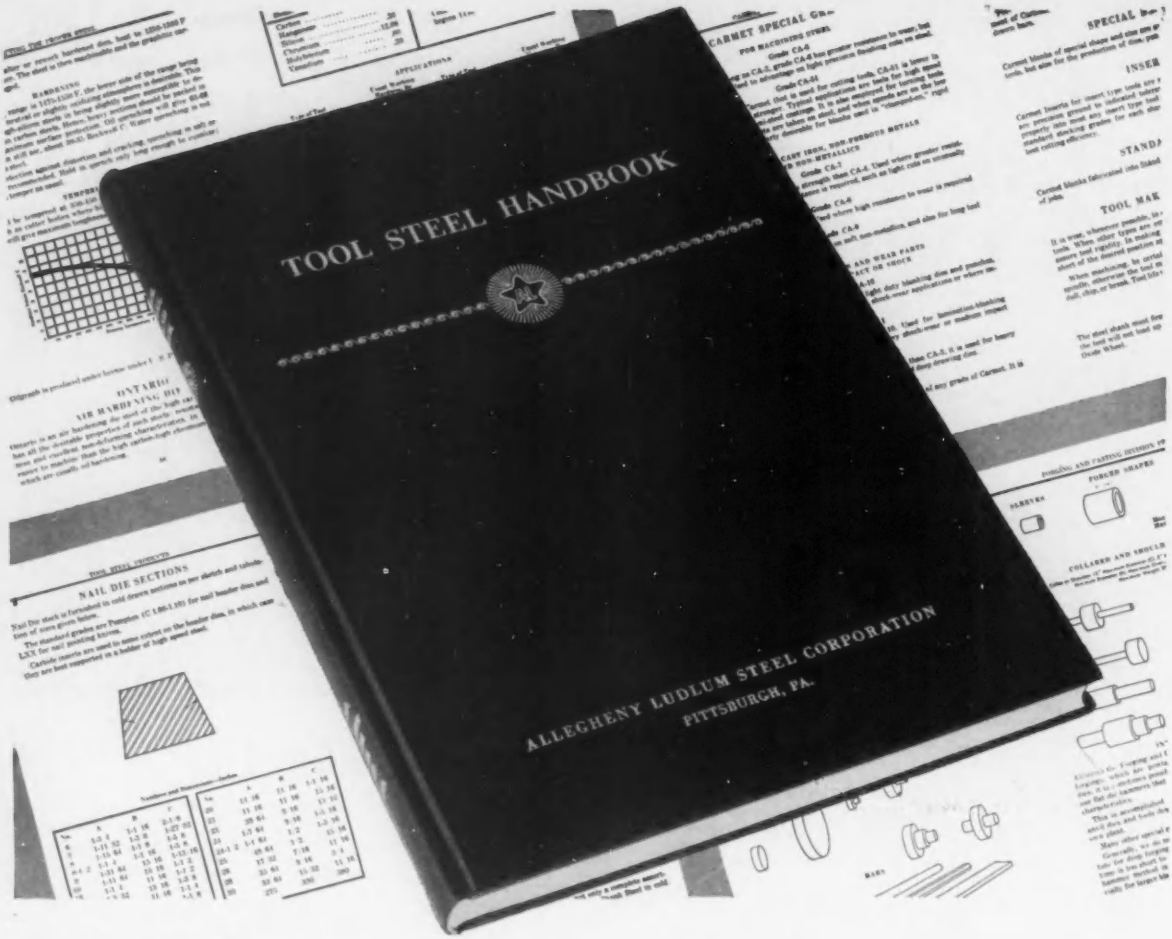
Our Technical Department's wide range of experience covers virtually the entire field of copper and copper-alloy applications in industry. If you have a problem of metal selection, we are at your service. *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.*

*Reg. U. S. Pat. Off. 5488

**ANACONDA®**

**the name to remember in**

**COPPER · BRASS · BRONZE**




# AVAILABLE NOW—196 pages of Valuable Tool Steel Information

Another printing of our Tool Steel Handbook—one of the most comprehensive treatises of its kind ever offered by a tool steel producer—is just off the presses. In addition to a relatively complete picture of Allegheny Ludlum Tool Steels, their properties, applications and the forms in which they are available, this 196-page as well as a complete set of weight tables and other useful reference material.

Your copy of the Tool Steel Handbook will be sent—*without charge*—upon request. Our only stipulation: please make your request upon your company letterhead. ● Write to *Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh*

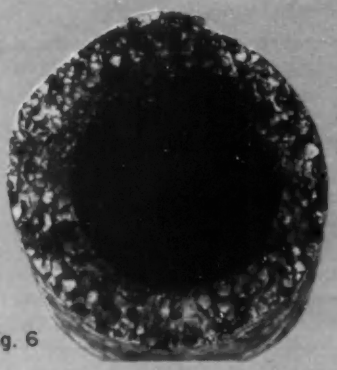


Fig. 6

Fig. 6—Brass aircraft turnbuckle that had broken while heated to a high temperature. Fracture surface shows extremely coarse grains and little ductility. The temperature at failure was sufficiently high to reduce the strength of the grain boundaries in the metal.

Fig. 7—Front axle of forged steel that failed in fatigue. Crack originated near the middle of the bottom of the part. More than half the cross section was cracked before the remaining portion failed from overload. Crack originated at point where forging flash was removed.

Fig. 7

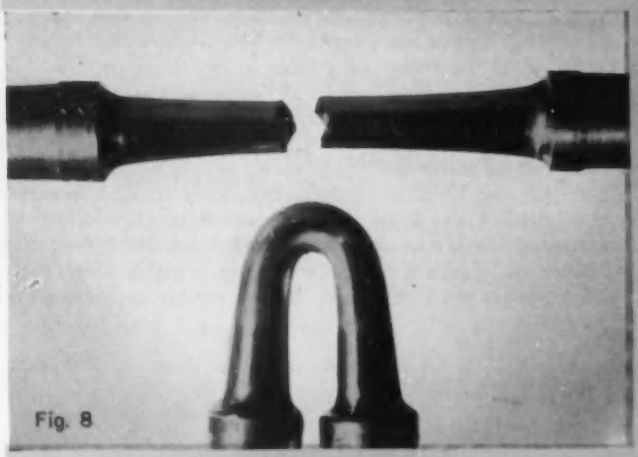


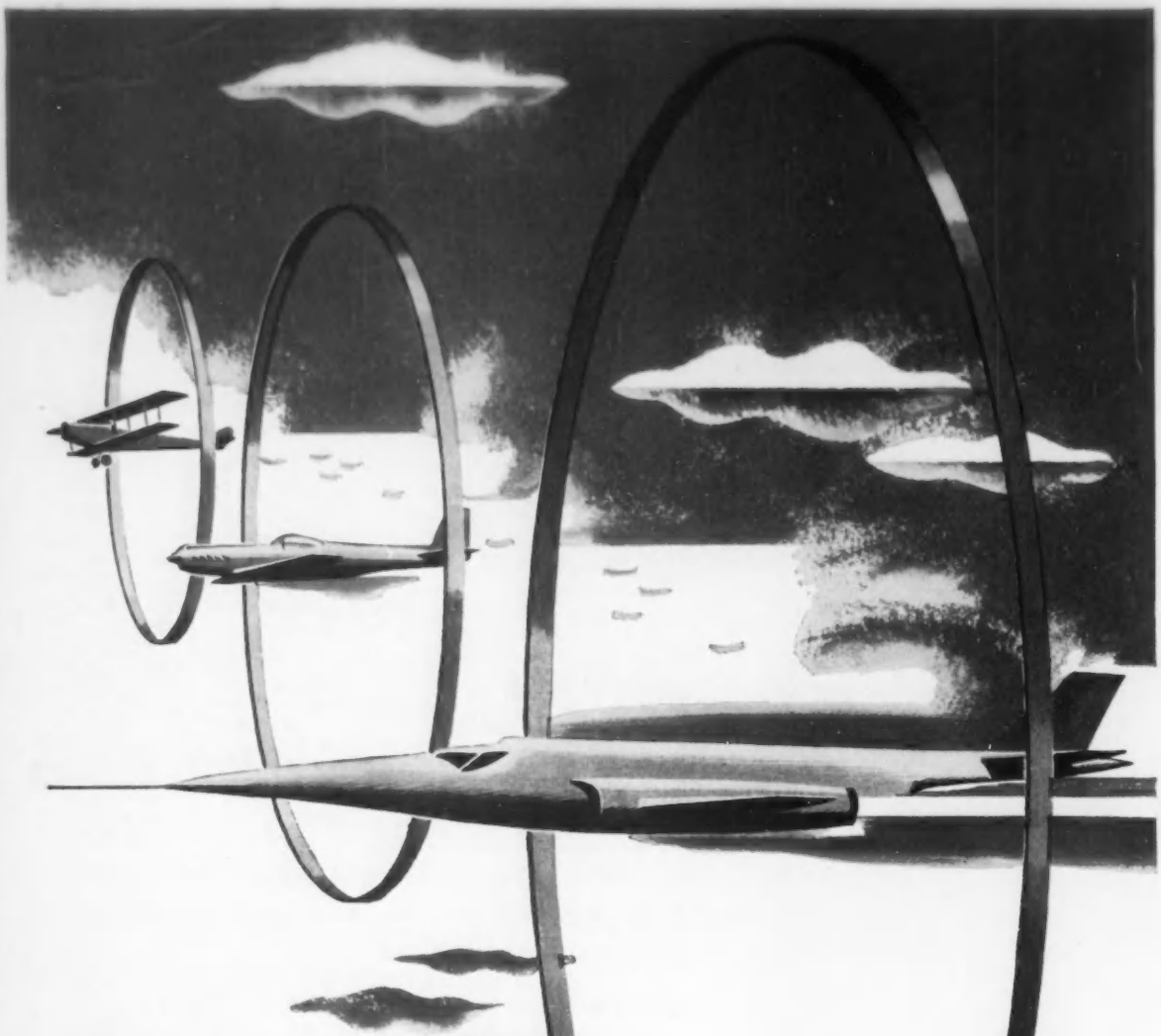
Fig. 8

Fig. 8—Effect of repeated stress on ductility. Identical specimens were loaded in bending. The upper one was subjected to many cycles of reversed loading and failed with a typical fatigue fracture, showing no ductility. A single high load was applied to the lower specimen causing only bending of the part.

surface of such a fracture shows two characteristic regions that are usually quite different in appearance. This is clearly shown in Fig. 7, where the area of the fatigue fracture at the bottom can be seen to be much smoother than

siderable area broken by overstress. This part will show some ductility, so fractures of this type will not fit together well when the parts are replaced in approximately their original relationship (the fatigue crack portion will

mary factor responsible for the fatigue failure of a part is much more often its geometry than the material of which it is made. A large percentage of the failures investigated could have been avoided by more careful design to



# The shape of rings to come

It is difficult to predict the shape tomorrow's air power will take. But one thing is certain — fabrication of many of the component parts, such as rings, bands, and the complicated assemblies will be accomplished by welding.

If a new alloy — a special metal — an intricate assembly pose a problem to design or manufacture perhaps our specialized knowledge gained in 35 years of welding fabrication can help to find a practical and economical solution. Our Product Development Division will be glad to put experience gained from working with every major U. S. jet engine manufacturer to work for you. In addition to fusion and resistance welding of ferrous and non-ferrous metals, American Welding can provide designing, engineering, metallurgical and machining facilities.

*Write us today for complete details*
*140 Dietz Road • Warren, Ohio*

**THE AMERICAN WELDING & MANUFACTURING COMPANY • WARREN • OHIO**

# ANACONDA METALS AT WORK

**A special alloy wire goes into the G-E SLEEP-GUARD Blanket ... sheet brass into the Westinghouse Thermometer Set ... and Everdur Copper-Silicon Alloys into the Sherwood Valve.**

## Shut-eye's safer with new shut-off control

Ahhh, sleep... it's wonderful! And now because of G. E.'s new SLEEP-GUARD Wiring System—made of two spiral wires separated by a nylon sheath—sleep's safer, too. If the heating wire becomes too warm, the nylon sheath—along with the heater and signal wire—automatically turns off your blanket. Both wires are made of Hitenso*, a cadmium bronze which provides just the right electrical and mechanical properties. We process almost 100 copper alloys into wire in a wide variety of sizes and shapes, tempers and finishes.

## A million at one clip for Betty

Anyone who's ever settled down before a TV set needs no introduction to charming Betty Furness of Westinghouse Studio One fame. Betty's currently offering her vast viewing audience this handy Westinghouse Kitchen Thermometer Set at a bargain price. And Westinghouse expects an overwhelming response. That's why they had Chaney Mfg. Co., Springfield, Ohio, make a million of these sets at one clip. And speaking of clips, those attached to these thermometers are made of coiled brass strip in the most economical alloy, gage and temper.

## Vive le valve plug!

The Aluminum and Brass Co., Lockport, N. Y., calls this valve plug—which employs a nylon insert and operates under pressures up to 3,000 psi—the "heart" of their Sherwood Oxygen Valve. We're mighty proud about their enthusiasm, since the plug is made of one of our Copper-Silicon Alloys. Everdur*-1015 was chosen because roll-threading not only frees it from burrs but also work-hardens its surface, making it less likely to wear, gall or "freeze." Everdur-1015's cold-working properties also allow it to be rolled *over* the nylon insert. A tight "cap" results.

## Want more information?

Our Technical Department's wide range of experience covers virtually the entire field of copper and copper-alloy applications in industry. If you have a problem of metal selection, we are at your service. *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.*

*Reg. U. S. Pat. Off. 5486

**ANACONDA®**

**the name to remember in**

**COPPER · BRASS · BRONZE**

# AVAILABLE NOW—196 pages of Valuable Tool Steel Information

Another printing of our Tool Steel Handbook—one of the most comprehensive treatises of its kind ever offered by a tool steel producer—is just off the presses. In addition to a relatively complete picture of Allegheny Ludlum Tool Steels, their properties, applications and the forms in which they are available, this 196-page case-bound book presents an extensive discussion of heat treating and handling techniques as well as a complete set of weight tables and other useful reference material.

Your copy of the Tool Steel Handbook will be sent—*without charge*—upon request. Our only stipulation: please make your request upon your company letterhead. ● Write to *Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pennsylvania.*

**ADDRESS DEPT. PE-56**

W&D 8125

## For complete MODERN Tooling, call Allegheny Ludlum

AL FINE TOOL STEELS SINCE 1854

# Automation with Miller CYLINDERS

## ...assures non-stop production flow with BIG savings in maintenance and investment cost!

The production magic of "AUTOMATION" demands faultless performance—as the failure of one important component of "automation" machinery and equipment can shut down an entire manufacturing process.

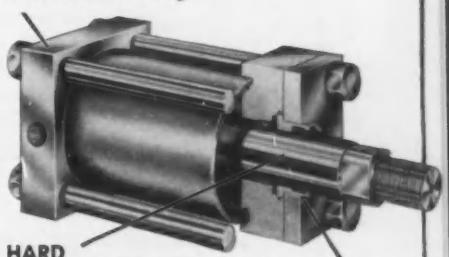
In the "automation" application illustrated above, 22 Standard Miller High Pressure Hydraulic Cylinders are employed on each of two identical automotive transfer machines built by Ex-Cell-O Corp. of Detroit, Michigan, a recognized leader in the design and manufacture of "automation" equipment.

The machines perform—simultaneously and automatically—drilling, countersinking, counterboring, and tapping operations on automotive cylinder heads. And the Miller Cylinders accomplish the vital clamping, feeding, holding, rotating and locating operations that enable the machines to function as smooth "automation" production units.

Miller Cylinders are ideal for such "automation" applications. They withstand severest shock loads, provide millions of smooth strokes without repacking of seals or other maintenance. Their space-saving square design cuts installation and designing costs. They're available in an infinite variety of versatile power and stroke units that cover every need and permit the most economical choice for the application. And they fully meet the J.I.C. Standards.

***Consult our engineering department or local representative. And write for complete information on this and other interesting applications and for our FREE Cylinder Bulletins A-105 and H-104.***

**SOLID STEEL HEADS, CAPS and MOUNTINGS**
Eliminate Breakage



**HARD CHROME PLATED PISTON RODS**
Prevent Scratch-Damage, Nicks and Rust

**DIRT WIPER SEALS**
Protect Rods, Seals, Bushings

***SALES AND SERVICE FROM COAST TO COAST***

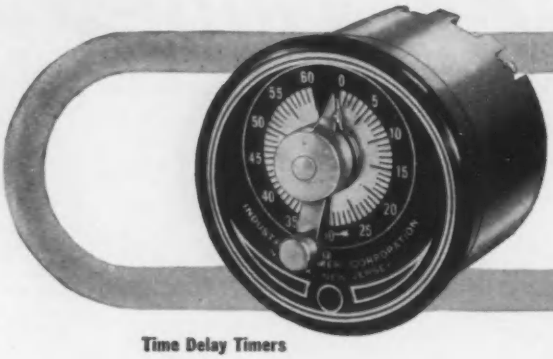
CLEVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND RAPIDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • TORONTO, CANADA and OTHER AREAS

Miller

**MILLER FLUID POWER CO.**

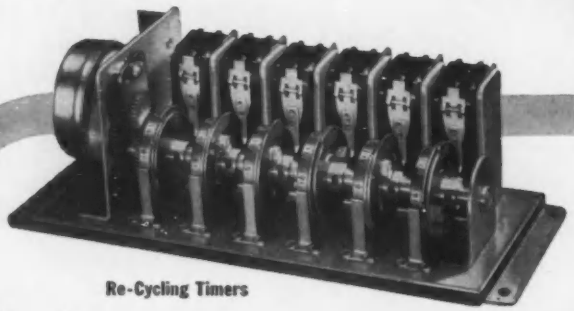
**2002-04 N. Hawthorne Ave., Melrose Park, Ill.**

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS



Time Delay Timers

Interval Timers



Re-Cycling Timers

Running Time Meters

**MOST COMPLETE LINE OF INDUSTRIAL**

# TIMERS for automation

The individual requirements of each automation problem are best met by selecting timers designed to perform specific functions. Whatever your timing-control problem, Industrial Timer Corporation can meet it with one of its standard timers, a combination of its standard units, or by designing an entirely new timing element. Our Engineering Department not only originates new designs, but also develops modifications to meet our customers requirements.

We manufacture a complete line of timers in these 4 broad classifications:

**TIME DELAY TIMERS • RE-CYCLING TIMERS**
**INTERVAL TIMERS • RUNNING TIME METERS**

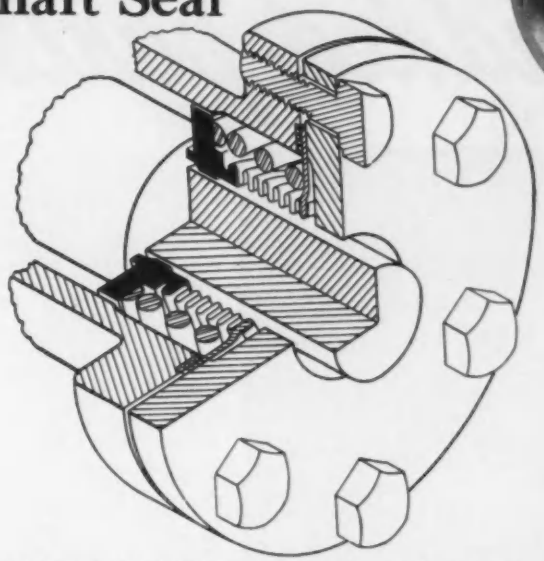
Our large stocks of 17 basic types from which we have developed over 660 combinations to date, enables us to make rapid deliveries in most cases . . . and excellent deliveries on special orders. Our automation timer specialists will be happy to discuss your automation timer requirements. Your inquiries will receive prompt attention.

*Timers that Control the Pulse Beat of Industry*

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
131 OGDEN STREET, NEWARK 4, N. J.

# How To Design A Bellows Type Shaft Seal



**BELLOWS SHAFT SEAL ASSEMBLY** is mechanically attached and sealed to shaft housing on one end. Seal nose at other end bears against shoulder on rotating shaft. The bearing surface of seal nose can be superfinished. Thrust is maintained by spring-action of the bellows, backed up by loading spring and remains constant regardless of pressure changes. Result: power output of shaft does not vary with pressure changes within the system. Wear occurs at an even, low rate. No tightening or take-up is required for the life of the seal.

## Advantages of Bellows Seals

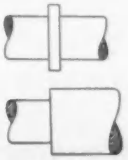
**Pressure Problems** Metallic bellows shaft seals have a long history of successful application in sealing shafts operating under fluid pressure conditions. A common example is their use in sealing the pump shafts of high pressure refrigeration systems.

By designing the seal nose and bellows to have equal effective areas, the thrust of the seal against the shaft face will remain constant and at a low value. Changes in internal or external pressures have no effect on the power output of the shaft and a tight seal is maintained.

**Temperature Applications** The all-metallic construction of bellows shaft seals make them effective over wide temperature ranges. In aircraft applications, bellows type seals operate under temperature extremes of —20F to 165F in pump shaft service. Even greater temperature ranges than these pose no problems for bellows shaft seals since they are not subject to deterioration due to heat and cold.

**Shock, Vibration, Misalignment** problems are frequently overcome by these seals because the bellows are inherently flexible and when a back up spring is incorporated in the design, they are ideal for such heavy duty applications as sealing torque converter shafts on trucks, military tanks and other large equipment operating under severe load conditions.

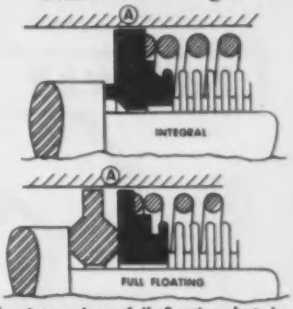
**Corrosion** Bellows shaft seals made of corrosion resistant metals such as stainless steels, monel, etc., greatly minimize corrosion problems. Several major manufacturers use them for sealing the shafts of gasoline and fuel pumps.



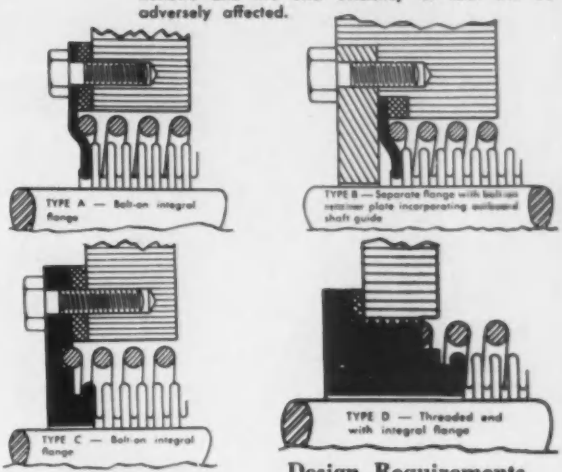
## Shaft Preparation

**The shaft to be sealed may either be turned down to provide a face for the seal nose to bear against, or a built-up ring may be provided. In either case the shaft face should be suitably finished for the intended service.** (7.4.12)

## Seal Nose Design

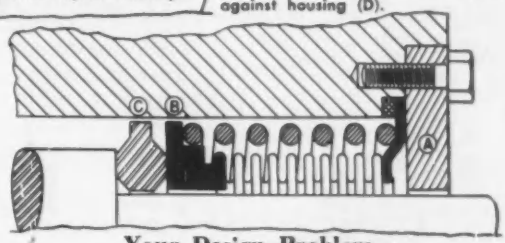



**Seal nose can be integral or full floating but in either case guide the nose piece from the stationary member (shaft housing) as shown at (A). Full-floating design is best. It is poor practice to guide seal nose from shaft since vibration will be transmitted to bellows and life and efficiency of seal will be adversely affected.**


TYPE A — Bolt-on integral flange
TYPE B — Separate flange with bolt-on retainer plate incorporating outboard shaft guide
TYPE C — Bolt-on integral flange
TYPE D — Threaded end with integral flange
TYPE E — Separate threaded flange

## Design Requirements

**The outboard end of the shaft seal must always be fastened rigidly to the stationary shaft housing and gasketed leak tight. Bellows should never be allowed to rotate with the shaft. Composite of good practice (below) shows use of an outboard shaft guide (A), nose piece guided against stationary housing (B) and use of full floating seal nose — also guided against housing (D).**



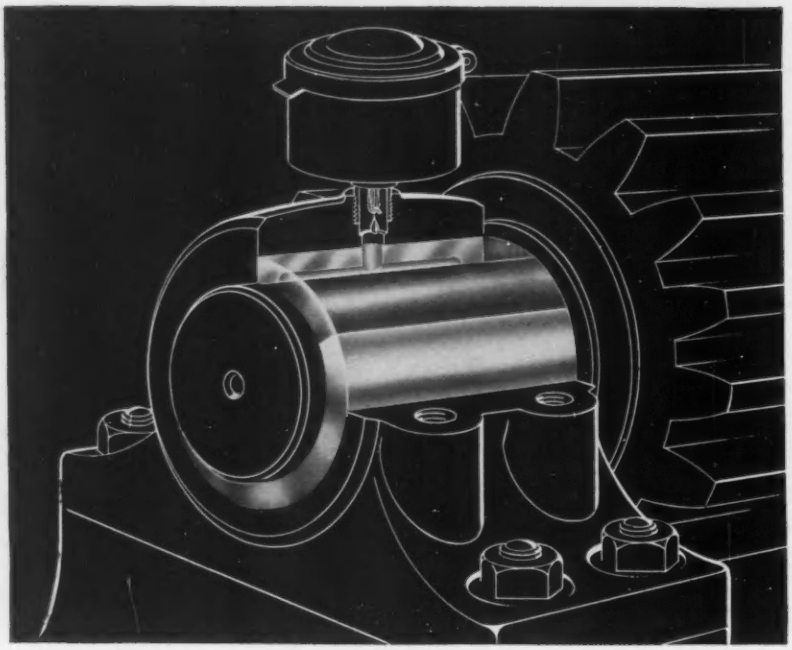

## Your Design Prob'em

If you are faced with a shaft sealing problem, you can get help direct from Clifford. Simply sketch the controlling dimensions, types of seal ends desired and service conditions to be met. We will recommend a design to meet your requirements and produce seals in any quantity.

Write: Clifford Manufacturing Company. 122 Grove Street, Waltham 54, Massachusetts. *Division of Standard Thomson Corporation.* Sales Offices in New York, Detroit, Chicago, Los Angeles and Waltham, Mass.

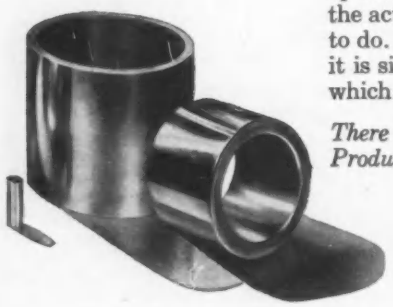
**THE WAY TO CUT...**

# *Cost of added parts*



Give careful thought to the added parts required for the satisfactory functioning of some bearing types and not necessary with the simple uncomplicated sleeve bearing. Lock nuts and lock washers needed to fasten some bearing types to the shaft are absent in sleeve bearing design. With the sleeve bearing there is nothing to lock to the shaft. Intricate end covers required for locating or enclosing some types of bearings again are absent in sleeve bearing design. Where the sleeve bearing is to be of the floating type it is simply inserted by hand in the part in which it is to operate. The bearing is delivered to you ready for installation with the actual easy assembly in housing and on shaft all that is left to do. Where the sleeve bearing is to be of the pressed-in type it is simply pressed into the gear, gear box, lever or housing in which it is to function.

*There is a Bunting Engineer near you. Consult him. Or write our Product Engineering Department at Toledo.*



**Bunting®**

**BRONZE BEARINGS • BUSHINGS • PRECISION BRONZE BARS**

**The Bunting Brass & Bronze Company • Toledo 1, Ohio • Branches in Principal Cities • Distributors Everywhere**

# Design to step up your machine performance, and you'll design to beat competition

Mr. W. B. Weathers, Manager, Machinery Electrification Sales, Westinghouse Electric Corporation

## WESTINGHOUSE CAN HELP WITH THESE DRIVES

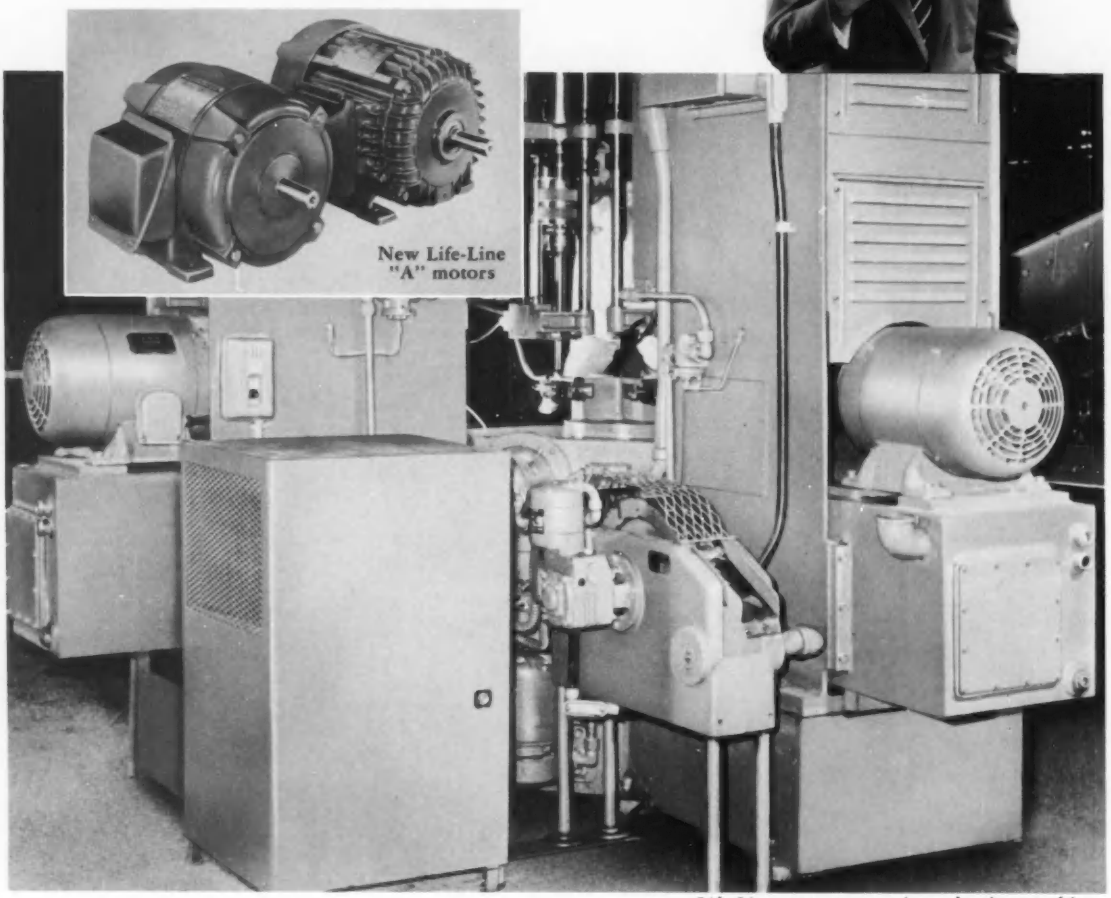
Here are some of the questions you have often asked yourself. How can we offer our customers new ways to higher uniform quality in manufactured goods? How can we offer lower production and maintenance labor costs, less down time, output spoilage and waste? How can we design the "answers" into our equipment?

The answers often lie in better application of electrical components, *to make maximum use of machine tools* and other production equipment, to power the equipment better and faster, to control that power precisely and unfailingly, and to sequence production operation to output requirements.

Then consider the extras Westinghouse Drives perform—better, longer, cheaper.

***On the following pages, Mr. W. B. Weathers, Manager of Machinery Electrification Sales of Westinghouse Electric Corporation, shows how.***

# 3 ways Westinghouse Drives take the measure of any production job




Life-Line motors powering a honing machine.

### 1. DESIGN FOR HIGHER PRODUCTION . . . New Life-Line® "A" better-protected motor gives greater reserve power for continual load changes

Rapid, extreme or repeated load changes mean heat. Consider these outstanding developments in the new Life-Line "A" cast-iron motor—a new, longer lived motor.

1. New Bondite, a silicone fortified thermoset varnish, means better temperature stability and better resistance to oil, water, chemicals . . . better protection for stator assemblies.
2. New Mylar*, a polyester film bonded to a reinforcing base, means slot insulation with greater dielectric and mechanical strength.
3. New Bondar, a conductor insulation, means more resistance to both heat and contaminants, with life expectancy more than 3 times that of the conventional conductor insulations.
4. New 4-way seal pre-lubricated bearing needs no lubrication . . . provides foolproof protection against under- or overgreasing, and against entry of foreign matter.

Consider these and many other new features in the new Life-Line "A". Why? Because the outage of Life-Line motors averages one-half that of conventional motors.

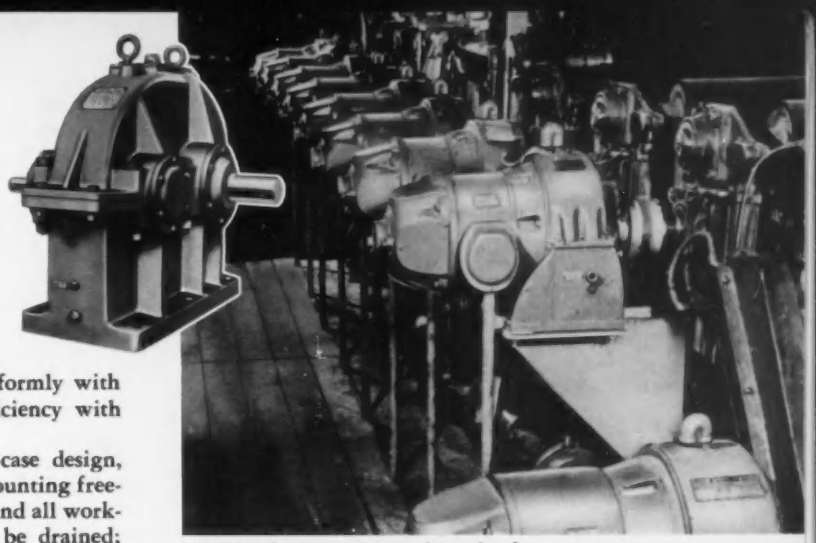
Westinghouse carries a complete line of motors—both a-c and d-c—for all of your motor requirements.

### 2. DESIGN FOR SPEED-REDUCTION EFFICIENCY . . . Life-Line gearmotors provide full range of speeds at 98% efficiency

Wherever gear reduction drives are required, Life-Line gearmotors, designed and manufactured com-

* Du Pont Registered Trade-Mark

YOU CAN BE SURE...IF IT'S



Life-Line d-c gearmotors and speed reducers

plete by Westinghouse, transmit power uniformly with a loss of 2% for each gearset—a 98% efficiency with single reduction units.

Because of their unique horizontal split-case design, Westinghouse Gearmotors provide greater mounting freedom. Case cover can be removed in minutes, and all working parts are then accessible. No oil need be drained; gearmotor mounting need not be disturbed! All bearings are firmly anchored in case foundation to assure positive bearing alignment and elimination of harmful vibrations.

Consider Westinghouse Gearmotors—the most efficient, versatile, reliable buy.

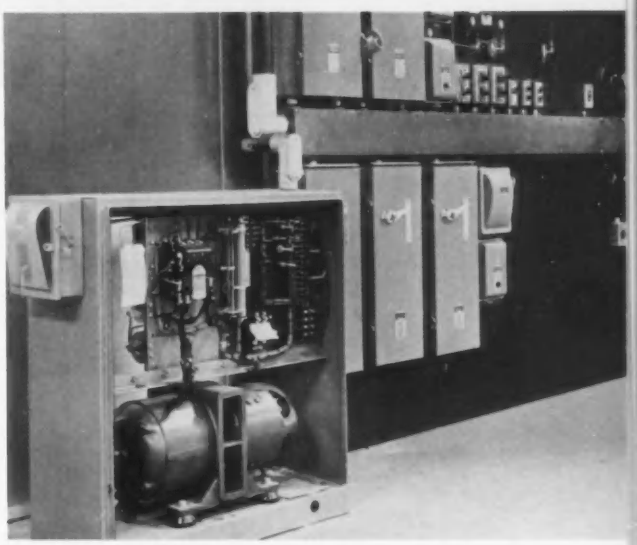
### 3. DESIGN FOR FINER SPEED ADJUSTMENT . . . with compact AV drive power package

The Westinghouse AV Drive enables you to provide d-c power from an a-c line, for individual machine tools or other equipment—on-the-spot power conversion. This drive is a complete, adjustable-voltage drive system, a factory-engineered package.

Consider these further advantages. With precise speed control, you can:

1. Provide smooth acceleration and deceleration.
2. Maintain optimum operating speeds regardless of load changes.
3. Match speeds of two or more drives to coordinate production processes.
4. Add many other functions such as inching, reversing, interlocking and sequencing, etc.

So, if you need fast, accurate control of speed over a wide range, consider the Westinghouse complete line of AV Drives.

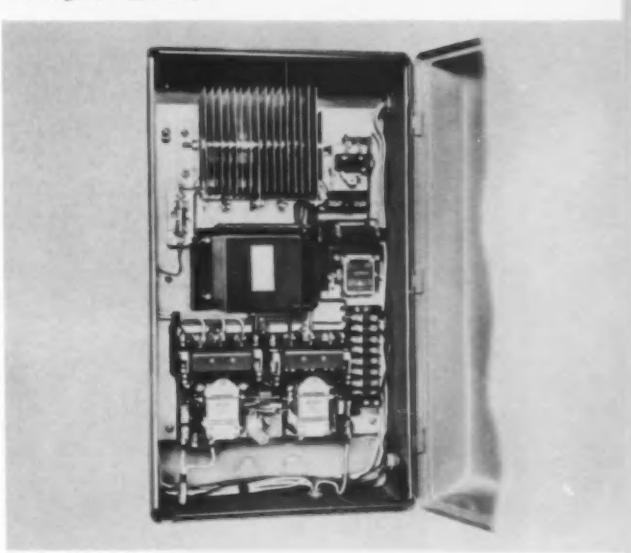


Westinghouse AV Drive

### AND HERE'S FASTER BRAKING . . . electrical braking control provides smoother, quicker stops

Here's a method of stopping a motor faster and more smoothly. Most machines can be brought to a standstill, under normal load, in just one second. This d-c braking controller eliminates jerky operations, wear of parts and periodic adjustment often associated with mechanical brakes. Its applications are many—it can be used where quick stops are necessary to permit tool changes, or to prevent damage to work or machine; where the possibility of reversal must be eliminated; or, where the same degree of braking is required in either direction.

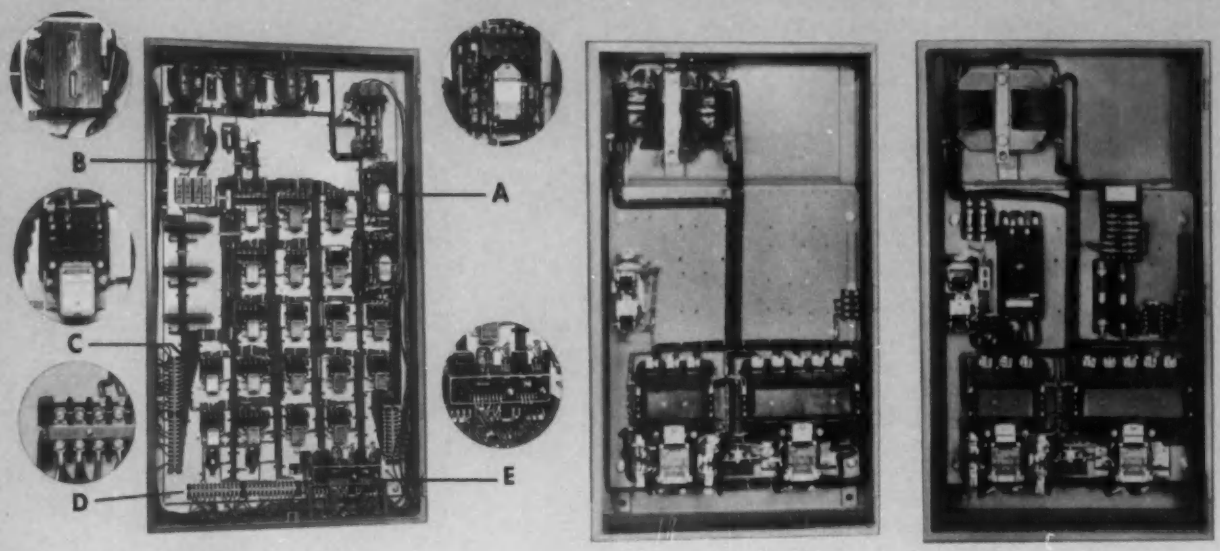
It will pay for itself by reducing coasting and nonproductive work time, reducing waste, improving product quality, improving safety, and saving space taken up by mechanical devices.



D-c braking control

Westinghouse

*Further information on the following page* ▶




(Left photo) **All-Westinghouse Panel** controlling honing machine: (A) Life-Line Starter, (B) Control Circuit Transformer, (C) Type N Relay, (D) Terminal Blocks, (E) Actotran.

(Middle photo) **Add-a-Part Panel** with provision for additional units. (Right photo) **Same Add-a-Part Panel** after addition of components.

Westinghouse
AB Circuit Breaker

# Full line of control components to contact, relay, interlock and break circuits

The typical machine tool control cabinet illustrated is equipped with all-Westinghouse components. These devices can be furnished for your machines either singly or in completely engineered and mounted panels to your specifications.

Control components—such as starters, contactors, relays, timers, breakers, switches, control circuit transformers, terminal blocks, and so on—providing for individual functions, may be combined to coordinate many control functions including starting, stopping, reversing, inching, regulating, protecting and switching.

## Add-a-Part Panel

Add-a-Part Panels are the newest and most versatile innovation to the reduced voltage starter line—and exclusive with Westinghouse. Add-a-Part is your assurance of complete application flexibility. Panels have drilled and tapped holes to accommodate required modifications on the spot to meet changing application conditions. Simply add transformers, fuses, interlocking relays, breakers or timing relays.

Only Westinghouse can offer Add-a-Part's savings in time, money and flexibility.

## Prompt, reliable maintenance backs up your Westinghouse Equipment

38 large apparatus repair shops coast to coast provide your customers maintenance for all types of electrical equipment. 56 field repair offices make on-the-spot repairs; 31 locations provide Genuine Westinghouse Renewal Parts. Extend your service with Westinghouse Service.

Here's help with literature; write to Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa. *New Life-Line "A" Motor* **B-6154**; *Life-Line SK D-C Motors and Generators* **B-4595**; *Life-Line AV Drive* **B-5808**; *Life-Line Gearmotors* **B-5645**; *Speed Reducers* **B-5646**; *Automatic Operations Start with Westinghouse Control* **B-5882**; *Complete Industrial Control and Services* **B-6051**; *Preventive Maintenance* **B-5477**.

MP-3027

YOU CAN BE **SURE**...IF IT'S Westinghouse

# Tube Application Adds New Beauty–Utility to New Car!

America's newest and most beautiful sports car—manufactured by the Nation's outstanding builder of fine cars—possesses new beauty and new utility because of a new application of Carpenter Stainless Tubing.

The twin tailpipes of this road-eating example of the automotive art are made from Carpenter Stainless. They resist the corrosive action of exhaust acids and corrosive atmospheres—stay bright—stay beautiful.

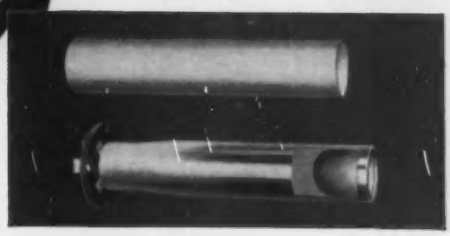
What's more, they are easy to fabricate. Although 10 separate steps are required to produce the finished part from the raw tube, swaging, rolling, cutting, spot welding and polishing are all accomplished without trouble.

Your fabrication, design or production problems may not be exact parallels to those outlined here . . . but whatever they are you may be sure that Carpenter Stainless Tubing *quality* can help solve them. For complete information consult your nearest Carpenter Distributor or write direct for your copy of the new Carpenter Condensed Data Bulletin.

**The Carpenter Steel Company, Alloy Tube Division, Union, N.J.**

*Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"*

*Shown below are original tubing and a completed tailpipe assembly after ten fabricating and assembly operations.*



**Carpenter**

**Stainless Tubing & Pipe**

# How would YOU solve these two problems?

**1. OVERDONE X-RAYS WON'T DO.** Water in developer tanks for X-rays must be kept at exactly 68°F — otherwise negatives come out over or underdone. The thermostat in the developer tank used by Johns Hopkins Hospital was subject to corrosion. Replacement with a stainless steel Fenwal THERMOSWITCH® unit solved the problem. It's accurate, won't corrode, lasts indefinitely since activating element is completely enclosed.

**2. WHERE THERE'S A SMOKEHOUSE,** there shouldn't be a fire hazard. Sawdust heated in the "smoke producer" used by Albert F. Goetze, Inc., meat packers, can easily break into flames. When this happens, a sensitive, quick-acting Fenwal THERMOSWITCH unit shuts down the blowers carrying the smoke to various curing rooms. Absolute reliability in the control unit assures maximum smoke without endangering the property.

**3. THIS IS IT** — the Fenwal THERMOSWITCH control is simple — compact shell contracts or expands *instantly* with temperature changes, opening or closing electrical contacts. Adjustable and highly resistant to shock and vibration. Fenwal THERMOSWITCH units are solving temperature problems and helping to improve the final product throughout all industry.

**4. SEND FOR THIS CATALOG** for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. **Write Fenwal Incorporated, 28 Pleasant St., Ashland, Massachusetts.**

Fenwal

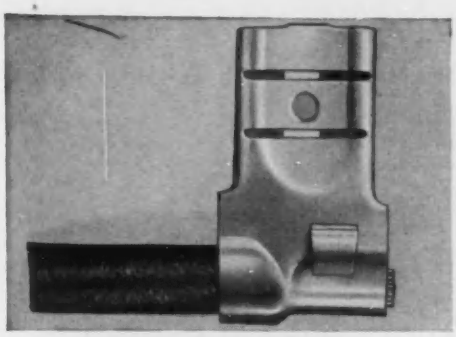
**THERMOSWITCH®**

**Electric Temperature Control and Detection Devices**

**SENSITIVE . . . *but only to heat***

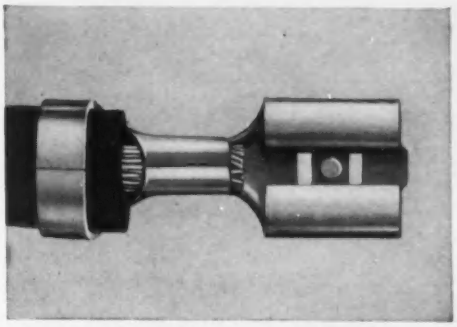
# now a complete line of AMP FASTON connectors

## EASIER, FASTER WIRING AT LESS COST



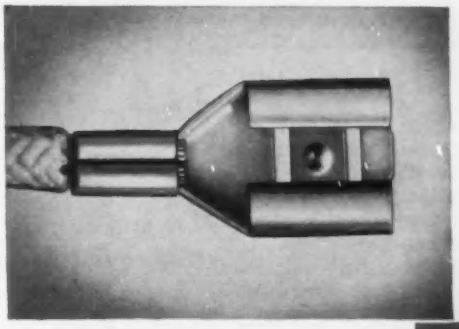
**NEW FASTON FLAG FEATURES "TAB-LOK" CRIMP DESIGN**

Here is the new A-MP FASTON Flag, the first right angle fast connecting type terminal to achieve electrical characteristics that will meet the most stringent tests without solder. Newly perfected crimp incorporating Locking Tab design and "Keystone Serrations" in inner wire barrel eliminates temperature rise and millivolt drop problems encountered with non-precision crimping methods.



**LARGE INSULATION SUPPORT FASTON**

Note special offset design which permits this FASTON connector to grip 5/64" wall and large insulation without overstressing the stripped wire or rupturing the insulation. Specially designed to provide perfect grip on heavy insulation U.L. specified wires (#16 to #12 AWG) used in Air Conditioning and Refrigeration Industry. Perfected for insulation diameter range of .210 to .265.



**STRAIGHT-ON FASTON SERIES**

These quick-to-apply terminals have found wide use in washers, dryers, ranges, refrigerators, and many other electrical appliances. Now available with and without insulation support for wire ranges from #22 to #12 AWG. Standard Stock Line includes terminals in bright dip, tin plated, and silver plated brass for varying corrosive environment and varying temperature requirements.

Precision engineered A-MP FASTON connectors are now available in several new styles rounding out the Complete FASTON Line designed especially for appliance and automotive wiring.

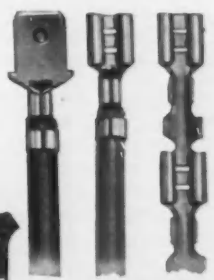
Where space limitations are important, A-MP's FASTON flag terminal (see top left) introduces a reliability never before achieved in a high speed solderless connection of the right angle variety. Four years in development, the New FASTON flag with perfected "Tab Lok" crimp on "Keystone Serrated" wire barrel will pass the most stringent temperature rise and corrosion tests without solder.

To the straight-on FASTON Series (wire ranges now 22 through 12 AWG) has been added the LARGE INSULATION SUPPORT FASTON connector to give perfect support to the wire in the .210-.265 insulation diameter range (as specified by UL for air conditioning and refrigeration products). See left center.

The most recent addition to the A-MP FASTON family is the new straight-on receptacle designed with a 22-20 wire barrel. It provides sure insulation support in the ranges of .090 through .135 outside insulation diameters. Precision engineered for timer leads, appliance lights, etc., it is the perfect answer for wire cost reduction programs.

Write today for more detailed information.

© AMP
AMP Trade-Mark
Reg. U.S. Pat. Off.

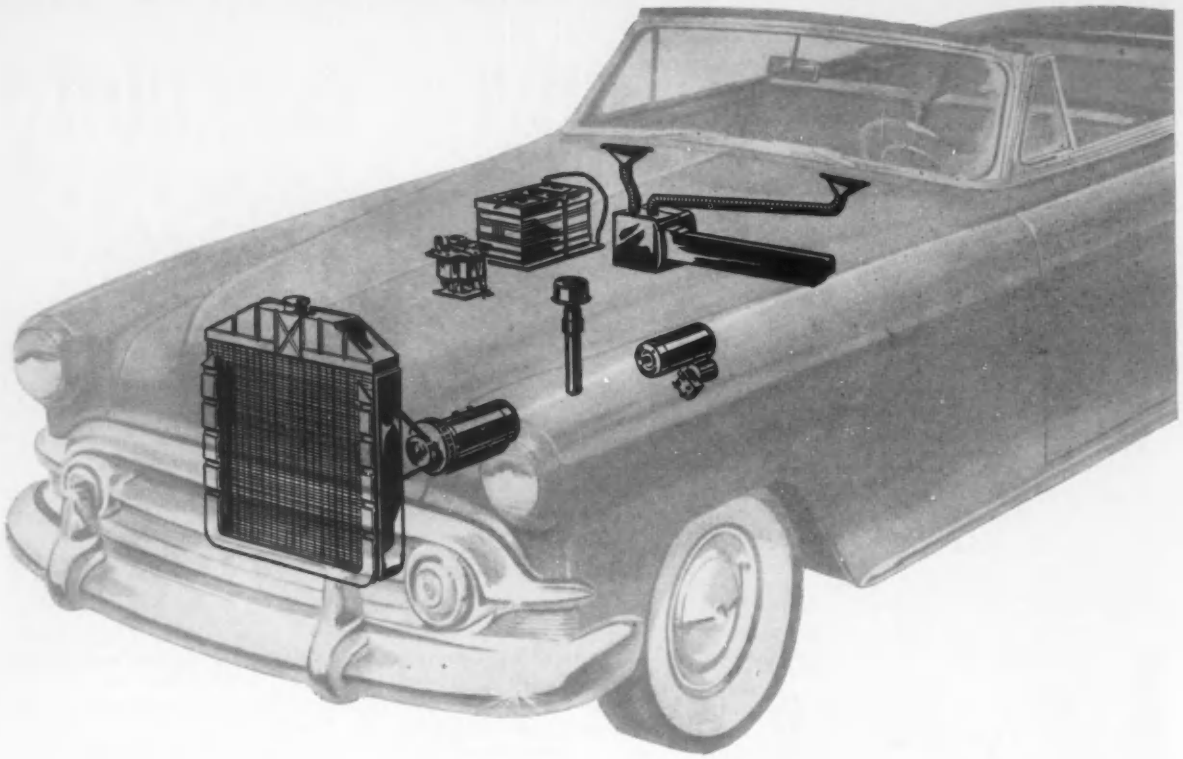


Find out about the New AMP "CREATIVE APPROACH TO BETTER WIRING"

...An evaluation survey without cost or obligation.

**Aircraft-Marine Products, Inc.**
**2100 Paxton Street, Harrisburg, Pennsylvania**

In Canada . . . . Aircraft-Marine Products of Canada, Ltd.
1764 Avenue Road, Toronto 12, Ontario, Canada



# *from Hydrazine, improved soldering fluxes*

A remarkable new series of soldering fluxes has been developed by McCord Corporation, one of the largest builders of automotive radiators, refrigeration and air conditioning surfaces, that makes possible greater economy and efficiency in production of soldered components.

Based on compounds of hydrazine, these fluxes, called CORONIL, are non-corrosive and can be used without hazard. They remove oxides and other films from most of the commercially used metals such as copper and brass—as well as others—to permit more effective work and fewer rejects. Currently, these hydrazine-based CORONIL soldering fluxes are being successfully applied in the manufacture of automotive radiators and other heat exchangers, parts for the electrical and electronic industries, carburetor floats, oil strainers, and various other products where effective non-corrosive soldering is essential.

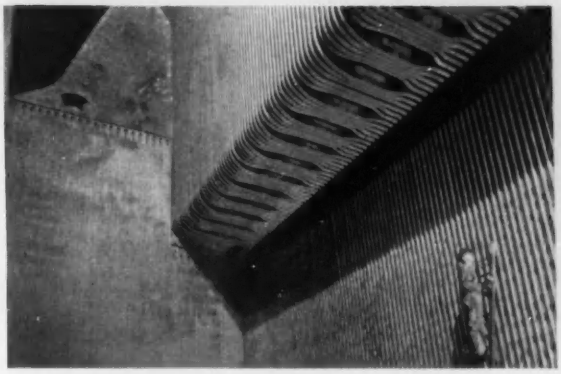
For additional information on hydrazine-based soldering fluxes, call your nearest Mathieson office or write today.

**MATHIESON CHEMICAL CORPORATION**
**Baltimore 3, Maryland**

**MATHIESON**

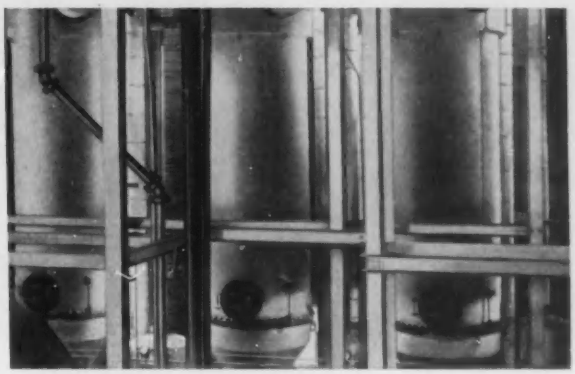
2503

# There's no limit to what you can do with the right tubing!



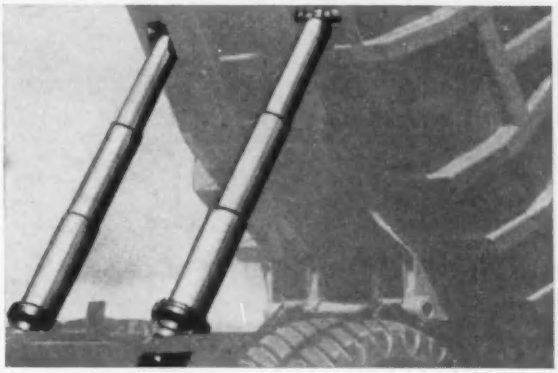
## make power to light a city . . .

**There are more than 12 miles of Globe seamless pressure tubing (carbon, alloy, and stainless) in this modern boiler which is a vital part of the electric power plant that serves a large metropolitan community.**



## transfer corrosive liquids . . .

**Black liquor, used in production of kraft papers, is highly corrosive and has to be carried under pressure in multiple effect evaporators. Gloweld (electric welded) Stainless Steel Tubing was found to do the job best—at lowest cost.**



## or lift a load of dirt . . .

**Mounted on a dump truck, these twin hydraulic hoists are built to handle heavy loads. Design and production is simplified by making the telescoping arms of Globe mechanical tubing.**

THERE are probably a thousand and one different tube applications that could be made in your own products or industry. Check the possibilities. Globe engineers will be pleased to give helpful advice on how the right tubing — Globe tubing — can help you save time, save money, save manpower. Write for literature on any of these products.

**GLOBE STEEL TUBES**

**GLOBE STEEL TUBES CO.**
**MILWAUKEE 46, WISCONSIN**

*Field Offices:* Chicago • Cleveland • Detroit • New York
Philadelphia • St. Louis • Denver • Houston
San Francisco • Glendale, Calif.

## A quick check list of GLOBE STEEL TUBES

**ALLOY STEEL:** to meet heat, corrosion, pressure, and structural strength problems. Carbon Moly, Chrome Moly Nickel and others. Sizes: O.D. from ½ to 6 inches. Wall thickness .035 to 1.000 inch.

**CARBON STEEL:** for load bearing structural members with strength, least weight . . . for fast, low-cost manufacturing of machine parts or pressure tubing applications. Low and medium carbon. Sizes: O.D. ½ to 7½ inches. Wall thickness: .028 to 1.000 inch.

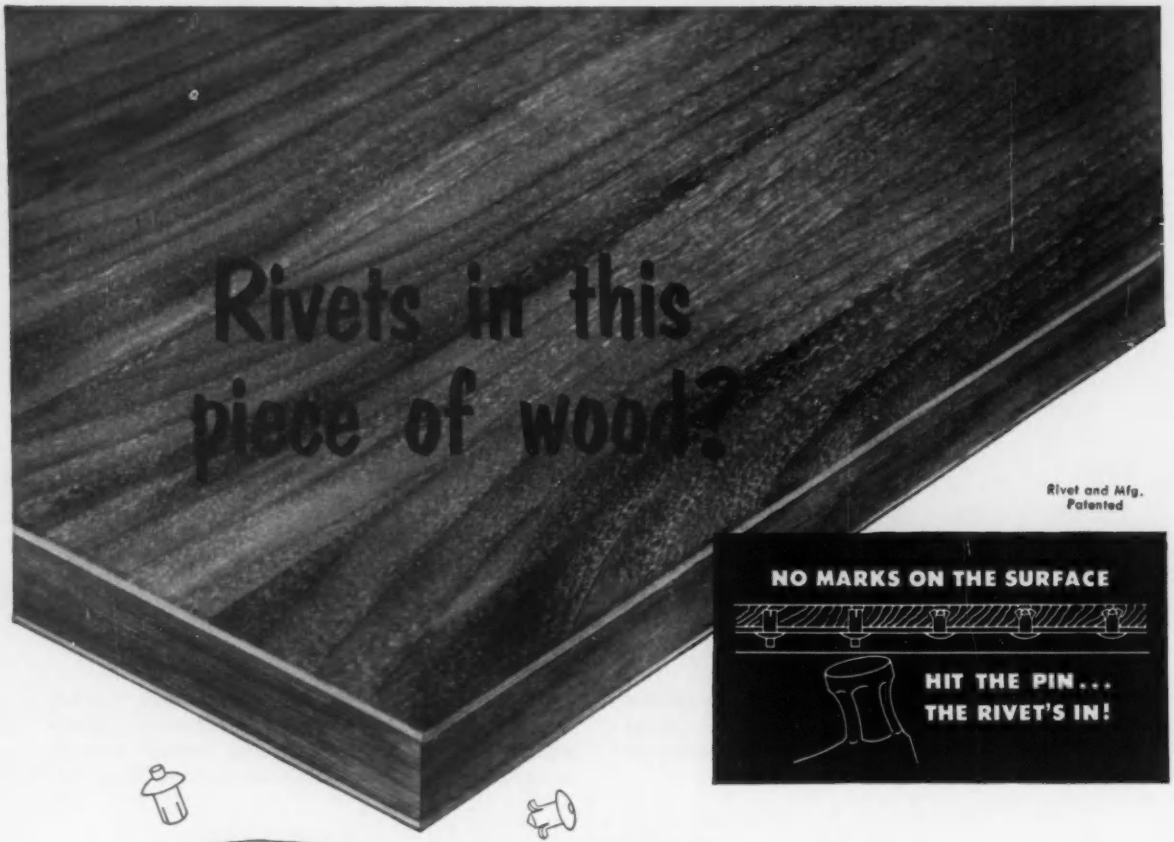
**STAINLESS SEAMLESS:** in sizes from ½ inch to 6 inches O.D., and in pipe sizes ⅛ inch to 6 inches, standard, extra strong and double extra strong weights.

**STAINLESS WELDED:** Gloweld electric welded stainless steel tubing offers many economies. Sizes: O.D. ¼ to 5 inches. In standard wt. pipe sizes ⅛ to 2 inches. In lightweight pipe sizes ⅛ to 4½ inches inclusive.

**HIGH PURITY IRON:** Globeiron tubing is 99.5% pure ingot iron. For applications where ductility, toughness, easy weldability and easy forming are desired or for use where magnetic permeability and electrical properties are required.

**SPECIAL ANALYSES:** Globe Steel Tubes Co. regularly produces tubing to special customer specifications. Consult with Globe's representatives for analyses to suit your needs.

**GLOBE WELDING FITTINGS:** seamless, carbon and stainless, available in a complete line of sizes and weights through Globe distributors in key cities.




**SOUTHCO® DRIVE RIVETS DON'T MAR THE SURFACE**

When fastening metal to wood with Southco Drive Rivets, a blind head forms *inside* the wood to provide firm holding power even in thin sections. Since nothing projects through the wood, there is no evidence of the fastener on the exterior surface . . . and, of course, no finishing operations are required.

Southco Drive Rivets are installed quickly . . . just hit the pin with a hammer. They won't vibrate loose or twist out. There is no problem of over or under driving, and powerful pull-up forces hold parts firmly together.

Get the complete story on Southco Drive Rivets.
Write Southco Division, South Chester Corporation
236 Industrial Highway, Lester, Pa.

©1954

**SOUTHCO® FASTENERS**

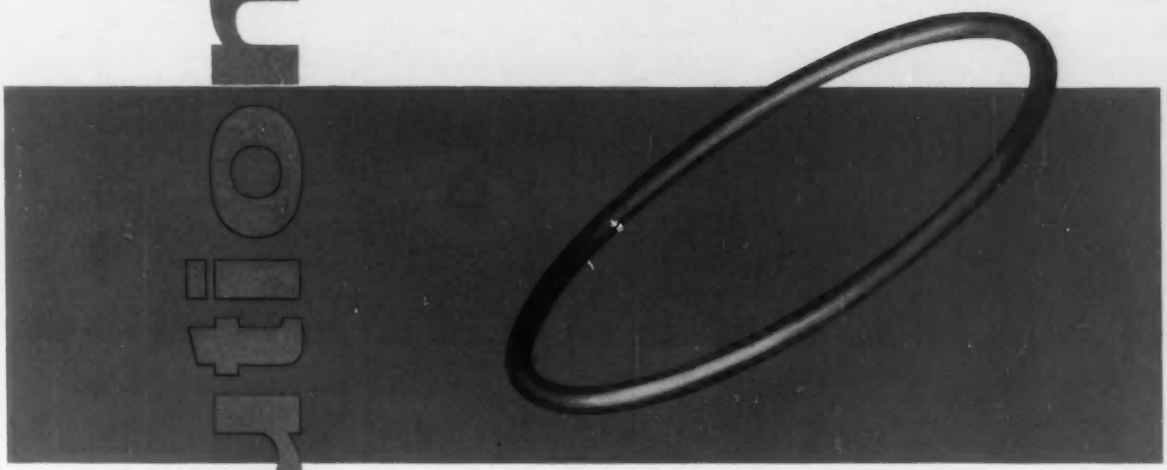
**PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES**

**OFFICES IN PRINCIPAL CITIES**

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER; STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

revolutionary

# NEW PROCESS PRODUCES SUPERIOR QUALITY "O" RINGS AT COMPETITIVE PRICES



## LINEAR ROTO-MOLDED "O" RINGS

Now, for the first time, you can use precision-made *compression-molded* "O" Rings, with all their inherent superiority, *at prices as low as injection molded "O" Rings!*

Exclusive with LINEAR, a new, high-speed process produces ROTO-MOLDED perfect circle "O" Rings with precise tolerances, extreme uniformity, flash-free finish and pre-stretched grain structure, at a lower cost than ever before possible.

This will be good news for your customers: low cost selling with greater resistance to heat, greater resistance to distortion under pressure, greater tensile strength and wearing qualities.

You can get these new LINEAR ROTO-MOLDED perfect circle "O" Rings in a variety of standard sizes and materials, including special types and sizes for specific applications.
For full information and prices, write or call LINEAR today.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

## Here's help in

# ORDERING HYDRAULIC VALVES!

Use the form below to get specific information, prices, circuit designs and other data you may need on hydraulic valves.

Rivett catalogs 190 standard models in all popular sizes, types, actions, piston designs and pressures. Nearly any hydraulic valve requirement you may possibly have can be filled by Rivett. And Rivett's Factory Engineers and experienced Sales Representatives will assist in planning the most efficient circuits for your operations.

**We are interested in the Hydraulic Valves checked below.**

☐ Send complete literature, specifications, and circuit information. ☐ Send quotations on items checked. ☐ Have our Rivett Representative call and supply circuit information. ☐ Our specific hydraulic problem is:_____

_____

_____

***Mail This Form Today. Or File For Future Use!***

**RIVETT LATHE & GRINDER, Inc.,**
**Fluid Power Division**
**Dept. PE-8 Brighton 35, Boston, Mass.**

☐ Hand
- Operation:
  - ☐ Threaded Stem
  - ☐ Lever
  - ☐ Knob
- Action:
  - ☐ Manual
  - ☐ Spring
  - ☐ Ball Detent

☐ Cam

☐ Foot

☐ Direct Solenoid Operated
- Mounting:
  - ☐ Pipe
  - ☐ Sub-Plate
- ☐ Double Solenoid No Spring
- ☐ Single Solenoid Spring Return
- ☐ Double Solenoid Spring Centered

☐ Solenoid Pilot Operated
- Mounting:
  - ☐ Pipe
  - ☐ Sub-Plate
- ☐ Double Solenoid No Spring
- ☐ Single Solenoid Spring Return
- ☐ Double Solenoid Spring Centered

☐ Oil Pressure Operated
- ☐ No Spring
- ☐ Spring Return
- ☐ Ball Detent
- ☐ Spring Centered

☐ Air Pressure Operated
- ☐ No Spring
- ☐ Spring Return
- ☐ Spring Centered

☐ Oil Pilot
- Mounting:
  - ☐ Pipe Line
  - ☐ Base
  - ☐ Foot
  - ☐ Panel

☐ Flow Control

☐ Check
- Mounting:
  - ☐ Pipe
  - ☐ Flange
- ☐ Spring Loaded
- ☐ Pilot Operated
- ☐ Pilot Operated with Pressure Breaker

☐ Shut Off

☐ Deceleration

☐ Relief

☐ Unloading

☐ Sequence
- ☐ Direct Operated
- ☐ Remote Operated
- ☐ With Integral Check

☐ Counter-Balance

**Sizes**

☐ ¼, ☐ ⅜, ☐ ½, ☐ ¾, ☐ 1, ☐ 1¼, ☐ 1½

**Pressures**

☐ 1500 P.S.I. ☐ 3000 P.S.I.

**Specify Valve Action Desired**

_____

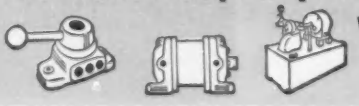
_____

_____

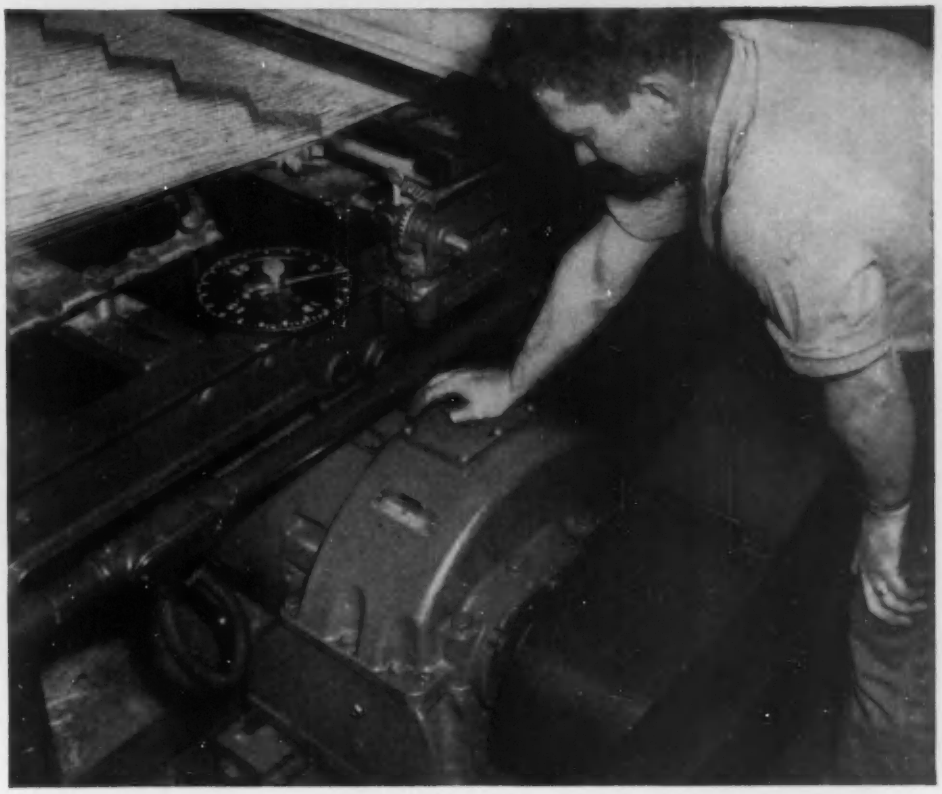
**NAME**_____ **TITLE**_____

**COMPANY**_____ **CITY**_____ **STATE**_____

**RIVETT** **furnishes a complete power package**



**VALVES • CYLINDERS • POWER UNITS**
Air and Hydraulic
All sizes and types



The Dana Warp Mills took advantage of Life-Line Gearmotors' compactness and operating efficiency. Shown is a Life-Line Gearmotor driving a delivery roll on a slasher.

# Close-Quarter Servicing No Problem when your drive is a Westinghouse Gearmotor

Powering equipment at the Dana Warp Mills meant putting compact and dependable drive units into cramped quarters. To meet space limitations, designers carefully selected gearmotors with minimum size and definite servicing advantages . . . they specified Life-Line Gearmotors.

Integral design of Life-Line Gearmotors provides maximum saving in space and means no intricate coupling or alignment problems.

Inspection and servicing of Life-Line Gearmotors is simple. Sight gauges on both sides of gear case enable quick detection of oil level. The gear case is split horizontally and by removing a few bolts, the gear cover can be lifted clear of the unit. This simple operation makes all working parts accessible without draining oil or disturbing the unit mounting. Machine alignment remains true.

Life-Line* motor features and tough, precision-made Westinghouse gears combine to give Life-Line Gearmotors lasting stamina, even on the most rugged jobs.

For detailed information, write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-07323

*Trade-Mark

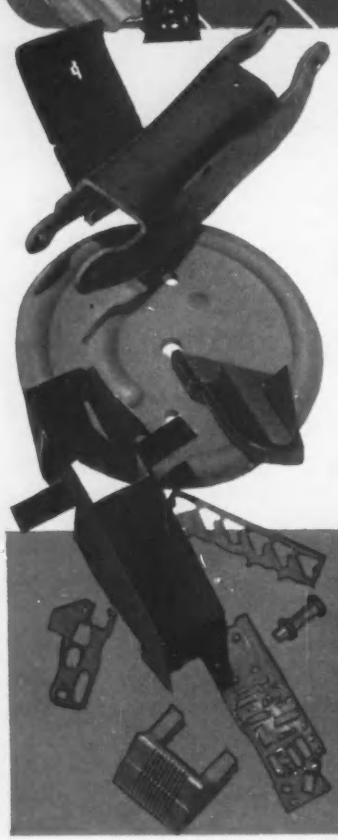
YOU CAN BE SURE...IF IT'S Westinghouse

# Spaulding

## A Common Denominator of

## Original Equipment Manufacture

## Spaulding Parts and Components



Because Spaulding basic materials have unlimited adaptability, parts and components which Spaulding fabricates from them are found in all types of manufactured products.

In their various types and grades, Spaulding materials present a wide range of physical, electrical and chemical properties in a great variety of combinations. Some of these properties are extreme light weight, high mechanical strength, good wearing qualities, excellent machinability, chemical inertness, low loss electrical insulation, arc resistance and deionizing properties.

Whether you manufacture or design agricultural machinery or airplanes, railroad equipment or kitchen ranges, radios or surgical appliances, chances are Spaulding materials may help improve or cut the cost of your product.

***Ask your nearest Spaulding representative***

**SPAULDING FIBRE COMPANY, INC., TONAWANDA, N. Y.**

### MAKERS AND FABRICATORS OF

**VULCANIZED FIBRE:** In sheets, rods, tubes and fabricated parts.

**ARMITE:** Thin Insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.

**SPAULDITE:** (Laminated Phenolic Plastic) in sheets, rods, tubes and fabricated parts.

**SPAULDO:** Motor Insulation in sheets, rolls, coils, slot cells and other fabricated parts.

**SPAULDING FIBRE BOARD:** In sheets and fabricated parts.

**SPAULDING T BOARD:** A superior Transformer Board, in sheets and fabricated parts.

**MATERIALS HANDLING EQUIPMENT:** Factory Trucks, Boxes, Barrels, Trays, etc.

**SPAULDING FABRICATING FACILITIES**

Spaulding's fabricating facilities for these products are unsurpassed the world over. You can save time and money by letting us do your fabrication. We'll be glad to quote on specific jobs without obligation to you.

### SPAULDING BRANCH SALES OFFICES

**BALTIMORE 18, MD.**
**BOSTON 16, MASS.**
**BRIDGEPORT 5, CONN.**
**CHICAGO 25, ILL.**
**CHICAGO 38, ILL.**
**CLEVELAND 14, OHIO**
**CLEVELAND 16, OHIO** (Rocky River)
**DAYTON 2, OHIO**
**DETROIT 1, MICH.**
**FORT WAYNE 6, IND.**
**LANSING 10, MICH.**
**LONG ISLAND, N. Y.** (Woodhaven 21)
**MILWAUKEE 8, WIS.**
**NEW YORK 55, N. Y.**
**NEWARK, N. J.** (Union, N. J.)
**PHILADELPHIA, PA.** (Camden 3, N. J.)
**ST. LOUIS 5, MO.**
**TONAWANDA, N. Y.**
**LOS ANGELES 15, CALIF.** C. D. LaMoree
**BERKELEY 10, CALIF.** C. D. LaMoree
**TORONTO 18, ONT., CANADA** A. A. Andersen & Co.

# DOWEL PINS

## HOW TO USE THEM

**1.** Precision Dowel Pins are principally used where parts must be accurately positioned and held in absolute relation to one another whether stationary or in motion. They facilitate quick disassembly and completely accurate re-assembly.

**2.** Allen Dowel Pins are also used as plug gauges.

**3.** As plugs for determining angular dimensions of dovetail slides.

**4.** As hinge and wrist pins in applications requiring initial and permanent accuracy.

**5.** As accurate, economical roller bearings and axles.

**6.** As guide pins, stops and position locators.

## HOW TO JUDGE THEM

**1.** *On precision, for low tolerance applications.* (Allen Dowel Pins are ground to a maximum microinch finish of 6 RMS protected by a rust preventive.)

**2.** *On strength, for shear resistance.* (Allen Dowel Pins are made from special Allenoy Steel, heat treated. Single shear strength measures from 160,000 to 180,000 psi.)

**3.** *On hardness of surface and a core hard enough to prevent "mushrooming" when driven into a tight hole.* (Allen Dowel Pins have a surface hardness of 62-64 Rockwell C Scale and core hardness of 52-54. Average case depth .010 to .020 depending on size.)

**The simple sure way to be sure of uniformly superior dowel pin quality is the same as in buying precision socket screws — *get genuine Allens from your Industrial Distributor.* Only he sells them but *we will welcome your direct request for literature or application engineering assistance.***

ALLEN HEAD

**ALLEN**

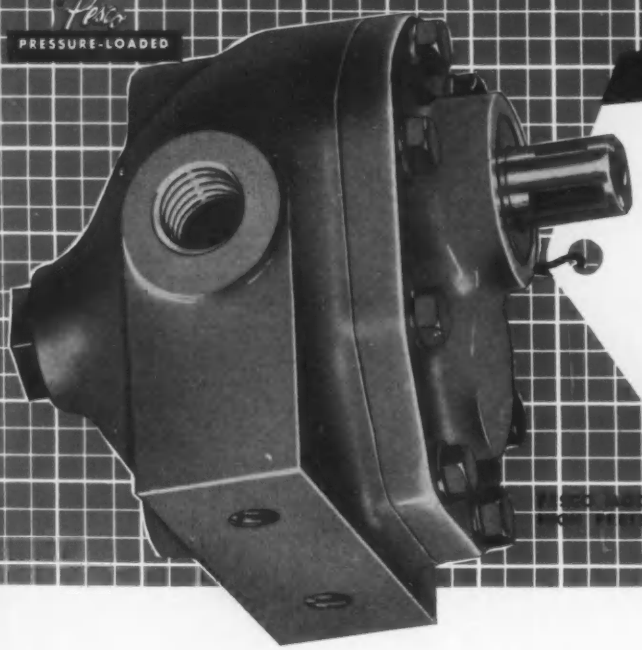
MANUFACTURING COMPANY

Hartford 2, Connecticut U.S.A.

Available in 108 Standard Sizes from ⅛" x ⅜" to 1" x 6". Standard tolerance .0002 oversize. Most sizes also standard in .001 oversize for repair work.

# HERE'S A REALLY GREAT HYDRAULIC PUMP... it's PROVED and AVAILABLE!

Pesco
PRESSURE-LOADED



DEPENDABLE OPERATION • LOW MAINTENANCE

Pesco
**HIGH PRESSURE GEAR PUMP**

PRESSURES UP TO 2000 PSI

EFFICIENCIES: VOLUMETRIC—UP TO 94%
MECHANICAL—UP TO 88%

OPERATION: CONTINUOUS DUTY WITH OIL AT 150° F.

CAPACITY: 11 GPM AT 2400 RPM

AUTOMATIC ADJUSTMENT FOR OPERATING WEAR

Here is a new Pesco *Pressure-Loaded* Pump you will want to investigate immediately! It is one of the most outstanding of many fine Pesco pump products, and provides unparalleled advantages for hydraulic power applications.

New developments of the famous Pesco Pressure-Loaded principle incorporated in this model have resulted in new high standards of performance and dependability. From the original development tests through many rugged field applications, this Pesco pump has constantly exceeded anticipated performance.

With volumetric efficiencies up to 94%, mechanical efficiencies up to 88%, and capacity of 11 gpm, it develops pressures up to 2000 psi. In addition, it operates on continuous duty with oil temperature of 150° F.

Pesco Hydraulic Engineers will be glad to show you how this outstanding Model 051002-110 will improve operation of your equipment. Simply call or write the Home Office, Bedford, Ohio.

*Call or write the Home Office, Bedford, Ohio for full information on Hydraulic Pumps, Power Packages, Hydraulic Motors, Electric Motors, Controls and Valves.*

engineering Pesco production
**PRODUCTS DIVISION**

AGRICULTURAL INDUSTRIAL AIRCRAFT AUTOMOTIVE CONSTRUCTION EARTH MOVING

PRODUCING THE BEST IN HYDRAULIC EQUIPMENT AND ELECTRIC MOTORS

**BORG-WARNER CORPORATION**
24700 NORTH MILES ROAD • BEDFORD, OHIO

# if you want lower V-Belt costs—

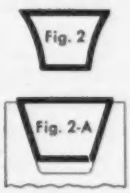
When a V-Belt bends, you can feel its sides change shape.

## —just make this simple test

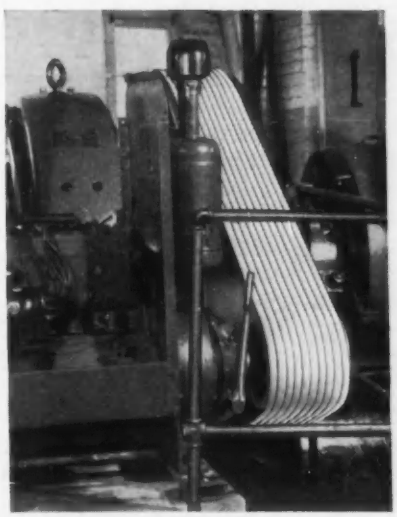
Take *any* V-belt that has *straight* sides (Fig. 1). Bend that V-belt while you grip its sides with your fingers. You will *feel* the sides *bulge out* (Fig. 1-A). Clearly, that out-bulge forces the belt to press *unevenly* against the V-pulley—and this *concentrates* wear at the points shown by arrows (Fig. 1-A).

### Now bend a Gates Vulco Rope with CONCAVE SIDES (Fig. 2)

(U.S. PAT. NO. 1813698)




Instead of *bulging*, the precisely engineered CONCAVE SIDES merely *fill out* and become perfectly straight. This belt, when bent, *precisely fits* its sheave groove (Fig. 2-A). The sides of the Gates Vulco Rope press *evenly* against the V-pulley. Therefore, wear is distributed *uniformly* across the *full face* of this belt —resulting in *longer* belt life and *lower* belt *costs* for you!



Typical Gates Vulco Rope Drive —the Gates V-Belts are built with Concave Sides to insure longer belt wear.

When you buy V-belts, be sure to get the V-belt with the Concave Sides—the Gates Vulco Rope!

Gates VULCO ROPE DRIVES

REG. U.S. PAT. OFF.

Gates Engineering Offices and Jobber Stocks are located in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

THE GATES RUBBER COMPANY
DENVER, U.S.A.

CS-543

*Designing for more customer satisfaction?*

**J-M Moulded Packing Cups,** installed on air cylinder piston of Morgan Laundry press, provide tighter, more efficient seal and eliminate troublesome maintenance problems

**When Morgan Laundry changed to J-M Moulded Packing Cups, they found**

# "Maintenance on packings practically eliminated..."

The Morgan Laundry, large supplier to hotels and institutions, encountered excessive down time for maintenance of their laundry presses. Packings supplied as original equipment on the air cylinder pistons of the presses needed frequent lubrication to prevent drying out. It was difficult to maintain proper cleanliness of the equipment.

When the company replaced the conventional material with J-M Moulded Packing Cups, packing life was increased. These packings required practically no maintenance, and the danger of soiling laundry because of relubricating packings was completely eliminated.

Designers and manufacturers can offer their customers many advantages by providing J-M Moulded Packing Cups on original equipment. These custom-made materials may be used on practically all types of air- or hydraulic-operated cylinders. They help improve operating efficiency, and they make possible easier, cleaner maintenance. These factors are especially important in critical installations such as hospitals and hotels, as well as laundries and other service establishments.

J-M Moulded Packing Cups are available in a variety of compositions to meet a wide range of pressures, temperatures and service conditions. For more information on all types of Johns-Manville Moulded Packing Cups, write to Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

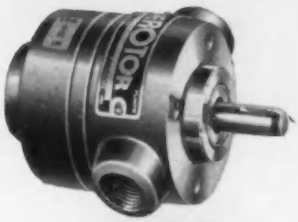
JOHNS-MANVILLE JM PRODUCTS

**Johns-Manville PACKINGS & GASKETS**

THAT FINE LINE OF PERFECTION

# *There's a* GEROTOR HYDRAULIC PUMP *to meet your requirements!*

The GEROTOR line of precision engineered hydraulic pumps is designed to fill the requirements of the majority of hydraulic equipment users. The three standard GEROTOR models cover a range of g.p.m. delivery from .4 g.p.m. to 40 g.p.m. Check the selection data for the pump to fill your needs.



## TYPE QDB

***Gerotor's NEW QDB series of small capacity pumps . . . the last word in precision engineering.***

| TYPE | DELIVERY G.P.M. — 1800 R.P.M. DISCHARGE PRESSURE P.S.I. | | | | |
|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | 1000 |
| QDB .4 | .42 | .40 | .38 | .35 | .31 |
| QDB .75 | .84 | .80 | .78 | .73 | .66 |
| QDB 1.5 | 1.67 | 1.62 | 1.57 | 1.50 | 1.42 |

**Selection Data**

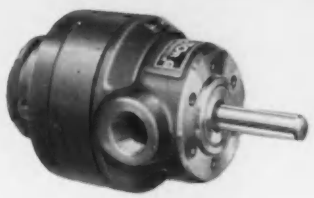
| TYPE | HORSEPOWER REQUIRED — 1800 R.P.M. DISCHARGE PRESSURE P.S.I. | | | | |
|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | 1000 |
| QDB .4 | .08 | .16 | .24 | .33 | .41 |
| QDB .75 | .13 | .27 | .41 | .56 | .71 |
| QDB 1.5 | .16 | .42 | .70 | 1.00 | 1.28 |

**PRESSURE**—Maximum continuous operating pressure is 1000 p.s.i.

**SPEED**—Standard design speed is 1800 r.p.m. Specific recommendations are made for applications at other speeds.

**ROTATION**—Standard rotation is clockwise facing shaft end. Counter-clockwise rotation is available.

**OIL**—Hydraulic oils with viscosity of approximately 300 s.s.u. at 100° F. are recommended.



## TYPE QDH

***The QDH . . . popular intermediate size of the Gerotor line***

| TYPE | DELIVERY — G.P.M. AT 1200 R.P.M. DISCHARGE PRESSURE P.S.I. | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | 1000 | 1200 | 1500 |
| QDH 3 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.7 | 2.5 |
| QDH 5 | 5.6 | 5.4 | 5.3 | 5.2 | 5.1 | 4.8 | 4.4 |
| QDH 8 | 8.6 | 8.5 | 8.4 | 8.3 | 8.2 | 8.1 | 7.8 |
| QDH 12 | 12.9 | 12.8 | 12.7 | 12.5 | 12.3 | 12.2 | 11.8 |

**Selection Data**

| TYPE | HORSEPOWER REQUIRED AT 1200 R.P.M. DISCHARGE PRESSURE P.S.I. | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | 1000 | 1200 | 1500 |
| QDH 3 | .25 | .7 | 1.2 | 1.6 | 2.1 | 2.5 | 3.4 |
| QDH 5 | .33 | 1.1 | 1.8 | 2.5 | 3.2 | 3.7 | 4.6 |
| QDH 8 | .4 | 1.5 | 2.7 | 4.2 | 5.4 | 6.3 | 7.9 |
| QDH 12 | .5 | 2.3 | 4.2 | 6.1 | 8.0 | 9.6 | 11.7 |

**PRESSURE**—Maximum continuous operating pressure is 1200 p.s.i., maximum intermittent 1500 p.s.i.

**SPEED**—Standard design speed is 1200 r.p.m. Specific recommendations are made for applications at other speeds.

**ROTATION**—Standard rotation is clockwise facing shaft end. Counter-clockwise rotation is also available.

**OIL**—Hydraulic oils with viscosity of approximately 300 s.s.u. at 100° F. are recommended.

## TYPE O

***Gerotor Series O . . . when larger capacities are needed***

| TYPE | DELIVERY — G.P.M. AT 1200 R.P.M. DISCHARGE PRESSURE P.S.I. | | | | |
|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | 1000 |
| O-20 | 20.0 | 19.5 | 18.8 | 18.0 | 17.2 |
| O-25 | 25.0 | 24.5 | 24.0 | 23.2 | 22.2 |
| O-30 | 31.2 | 31.0 | 30.5 | 29.8 | 29.0 |
| O-40 | 43.0 | 42.5 | 42.0 | 41.5 | 40.0 |

**Selection Data**

| TYPE | HORSEPOWER REQUIRED AT 1200 R.P.M. DISCHARGE PRESSURE P.S.I. | | | | |
|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | 1000 |
| O-20 | 1.0 | 4.0 | 7.2 | 10.5 | 13.5 |
| O-25 | 1.5 | 5.0 | 8.8 | 12.0 | 15.6 |
| O-30 | 2.0 | 6.5 | 10.9 | 15.5 | 19.5 |
| O-40 | 3.0 | 9.0 | 15.0 | 21.0 | 27.5 |

**PRESSURE**—Maximum continuous operating pressure is 1000 p.s.i., except type O-40, which is recommended for only intermittent duty at 1000 p.s.i.

**SPEED**—Standard design speed is 1200 r.p.m. Specific recommendations are made for applications at other speeds.

**ROTATION**—Standard rotation is clockwise facing shaft end. Counter-clockwise rotation is available.

**OIL**—Hydraulic oils with viscosity of approximately 300 s.s.u. at 100° F. are recommended.

Whatever your needs in hydraulic pumps . . . consult the GEROTOR engineers. Write for FREE literature and information, no obligation, of course.

**GEROTOR MAY CORPORATION**
P. O. Box 86—Baltimore 3, Maryland

# GEROTOR

## HYDRAULIC PUMPS — HYDRAULIC MOTORS

**Pneumatic Bin Evacuators — Precision Contract Manufacturing**

**B SERIES** • Light duty, one direction ball thrust bearing. Flat seat. Flat races. Bronze ball retainer . . . 38 sizes ½" to 3½" I.D.

**C SERIES** • Light duty, one direction ball thrust bearing. Flat seat. Flat races. Pressed steel retainer . . . 16 sizes ½" to 1⅞" I.D.

**F SERIES** • Light duty, one direction thrust bearing. Flat seat. Grooved races. Pressed steel retainer . . . 43 sizes ½" to 3½" I.D.

**G SERIES** • Medium duty ball thrust bearing. Grooved races. Pressed steel or bronze (large sizes) retainer . . . 76 sizes ½" to 7¾" I.D.

**E SERIES** • Medium duty ball thrust bearing. Banded. Flat seat. Grooved races. Full complement of balls . . . 40 sizes ½" to 3½" I.D.

**1000 SERIES** • Light duty ball thrust bearing. Flat seat. Grooved races. Pressed steel retainer. Metric standard . . . 26 sizes 10 to 125 mm. I.D.

**1100 SERIES** • Medium duty ball thrust bearing. Grooved races. Pressed steel or bronze (large sizes) retainer . . . 23 metric sizes 10 to 140 mm. I.D.

**1400 SERIES** • Medium duty. Grooved races. Spherical seat. Pressed steel or bronze (large sizes) retainer . . . 23 metric sizes 10 to 140 mm. I.D.

**W SERIES** • Case hardened and ground flat washers for various Thrust and Spacer applications. Slip fit. 38 sizes ½" to 3½" I.D.

**R SERIES** • Ball thrust retainer. One piece, pressed steel, channel type cage . . . 79 inch sizes 0.366" to 4.232" I.D.

Judged by every quality and performance standard Aetna bearings measure up to modern industry's increasingly exacting needs. That's why Aetna has a customer list that reads like Who's Who in American Industry—why 80% of Aetna's business comes from firms it has served for 20 or more years. Aetna has specialized on the advanced development, production and application of high precision anti-friction products for nearly four decades. Be sure to give this valuable background of experience your serious consideration when planning improvements of your present products or developing new ones for future production. We welcome your inquiry.

**CLUTCH BEARINGS** • Ball thrust clutch release bearing. Banded. Pre-lubricated. T-type, oil impregnated bronze retainer assures concentricity and smooth, quiet, long-life performance.

**Aetna**

*Precision Bearings and Parts for Every Branch of Industry*

**AETNA BALL AND ROLLER BEARING COMPANY**

DIVISION OF
PARKERSBURG-AETNA CORPORATION

**4600 SCHUBERT AVENUE**
**CHICAGO 39, ILLINOIS**

**SPECIAL BEARINGS** • Facilities for sizes up to 38" O.D. Counsel that brings you the expert technical aid that has licked many of industry's toughest bearing application problems.

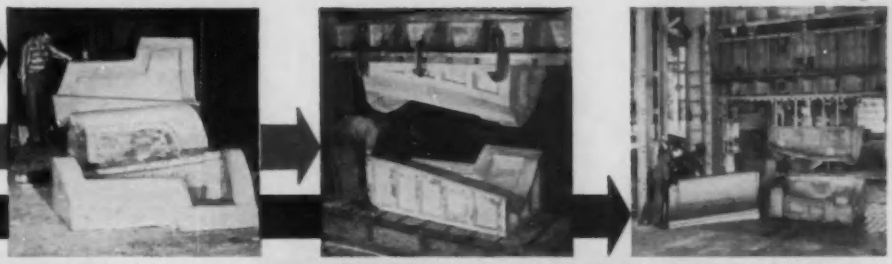
**PRECISION PARTS** • Aetna is versatile—can mass-produce vital parts in almost limitless sizes and shapes—to your most exacting metallurgical, tolerance and finish specifications.

***Write*** **for latest catalog. Contains specifications on Aetna's complete line—vital technical reference data on bearing selection, load capacities, lubrication, care and maintenance.**

The PATTERN

The DIE

The STAMPING



# . . . to Completely Finished PROTOTYPE PARTS READY FOR ASSEMBLY

It's Allied that offers the *complete* service to provide you with die-made prototype parts.

Plaster patterns . . . low-cost, quickly-produced dies made of plastic or zinc alloy . . . stampings accurately drawn and formed on Allied presses . . . completed parts which have been hand trimmed, flanged, pierced and spot finished . . . are all produced by Allied.

Not only is full responsibility for such a prototype program centered at one source but many economies can be effected from which you as a customer can benefit. In the building of the dies, for example, combinations of plastic, zinc alloy or steel (all of which Allied supplies) give you the best and most economical tooling for your volume requirements. In the finishing processes, as one more example, the tools themselves are often used for flanging and other purposes—additional cost-saving and accuracy-assuring operations.

If you need sheet metal stampings for prototype assemblies, you should investigate Allied's all-inclusive service. A visit to our Plant 4 in Hillsdale, Michigan will convince you that here is a positive method of insuring an economical and rapid transition from prototype to high volume production. If a visit is not convenient, let us supply you with complete information.

*Other Allied Products*

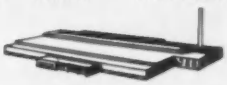
SPECIAL COLD FORGED PARTS • STANDARD CAP SCREWS • HARDENED AND PRECISION GROUND PARTS • R-B INTERCHANGEABLE PUNCHES AND DIES

ALLIED PRODUCTS CORPORATION

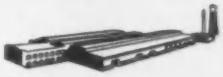
DEPT. D-19 12639 BURT ROAD DETROIT 23, MICHIGAN

PLANT 1
Detroit, Mich.

PLANT 2
Detroit, Mich.



PLANT 3
Hillsdale, Mich.



PLANT 4
Hillsdale, Mich.

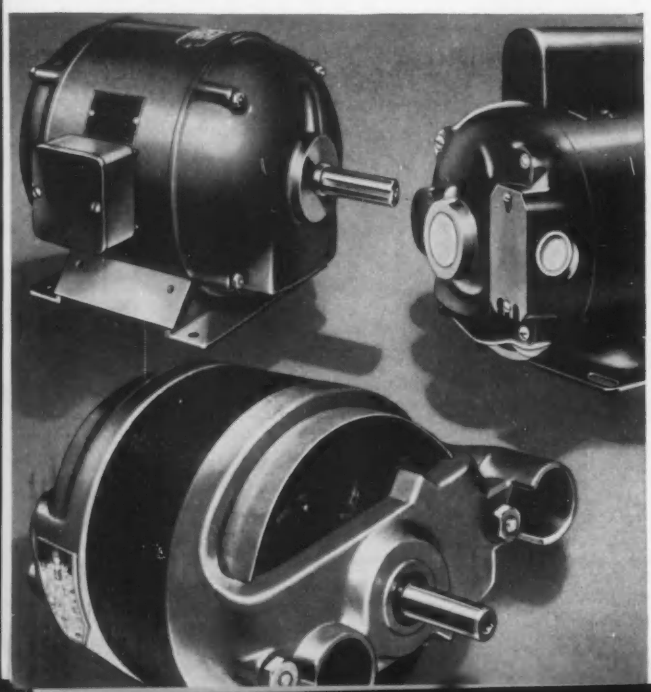
# Complete Motors...

# ...or Motor Parts

**Let your *design problem* make the choice!**

Standard motors and matched motor parts represent only the beginning of what R & M is qualified to build! Special R & M fractional-horsepower motors with *any* housing design—or specially designed motor parts to fit your housings—are regular R & M contributions to products such as those listed below:

- Portable Saws
- Drills
- Nut Setters
- Hammers
- Routers
- Screw Drivers
- Hedge Trimmers
- Lawn Mowers
- Nibblers
- Lock Mortisers
- Valve Grinders
- Vacuum Cleaners
- Fans
- Sanders
- Pumps
- Compressors
- Hones
- Business Machines
- Cast Cutters
- Food Mixers
- Polishers
- Planers
- Portable Grinders
- Sirens
- Advertising Devices
- Ventilating Equipment
- Oil Burners
- Surgical Instruments
- Grease Guns
- Vibrators
- Die Sinkers
- Waxers



# 19 MUSCLES for an electronic super-brain!

***With the help of R & M Motors, the new IBM Electronic Data Processing Machine solves in 7 minutes a problem that would take 7 years with an ordinary desk calculator.***

Imagine adding and subtracting 16,666 times per second; multiplying and dividing 2,192 times per second; "remembering" stored factors in 12 millionths of a second! That's what the IBM electronic computer means as a time-saver for industry.

If *you* have motors in your products, there's another significant fact about this outstanding development: *Robbins & Myers built 19 motors for use in this machine.*

Leading producers of motor-driven tools, machines and appliances recognize R & M as the *one* source that makes a specialty of building *exactly* the motor needed. Of course, if a standard R & M motor will do the job—fine. We build thousands of them. But, we also *custom-design* motors to your requirements. In short, the recommendations of R & M engineers aren't prejudiced by any limitations of stock designs . . . you don't have to compromise with what's *right.*

If you have a motor problem . . . or a new product design on the boards . . . write us today. Any details you give us about your problems will help us to give you more specific recommendations. They will be held in confidence, of course.

## ROBBINS & MYERS, INC.

MOTOR DIVISION: SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

Fractional & Integral h.p. Motors & Generators

Moyno Pumps

Propellair Industrial Ventilating Equipment

Electric Fans

Electric & Hand Hoists & Cranes

**R & M MAKES BOTH!**
**Fractional-horsepower motors and parts . . . from 1/200 h.p.**

*If it's an* **R&M**, *it's the Right Motor!*

**Integral-horsepower motors; famous R & M "All-Weather"* with sealed bearings. Up to 125 h.p.**

**"All-Weather" is an R & M trademark*

***This coupon will bring you prompt information.*** PE

**Robbins & Myers, Inc., Motor Division, Springfield 99, Ohio**

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ R & M "All-Weather" Motors —up to 125 h.p.
- ☐ Please have a Motor Specialist call

*Product we manufacture:* _____

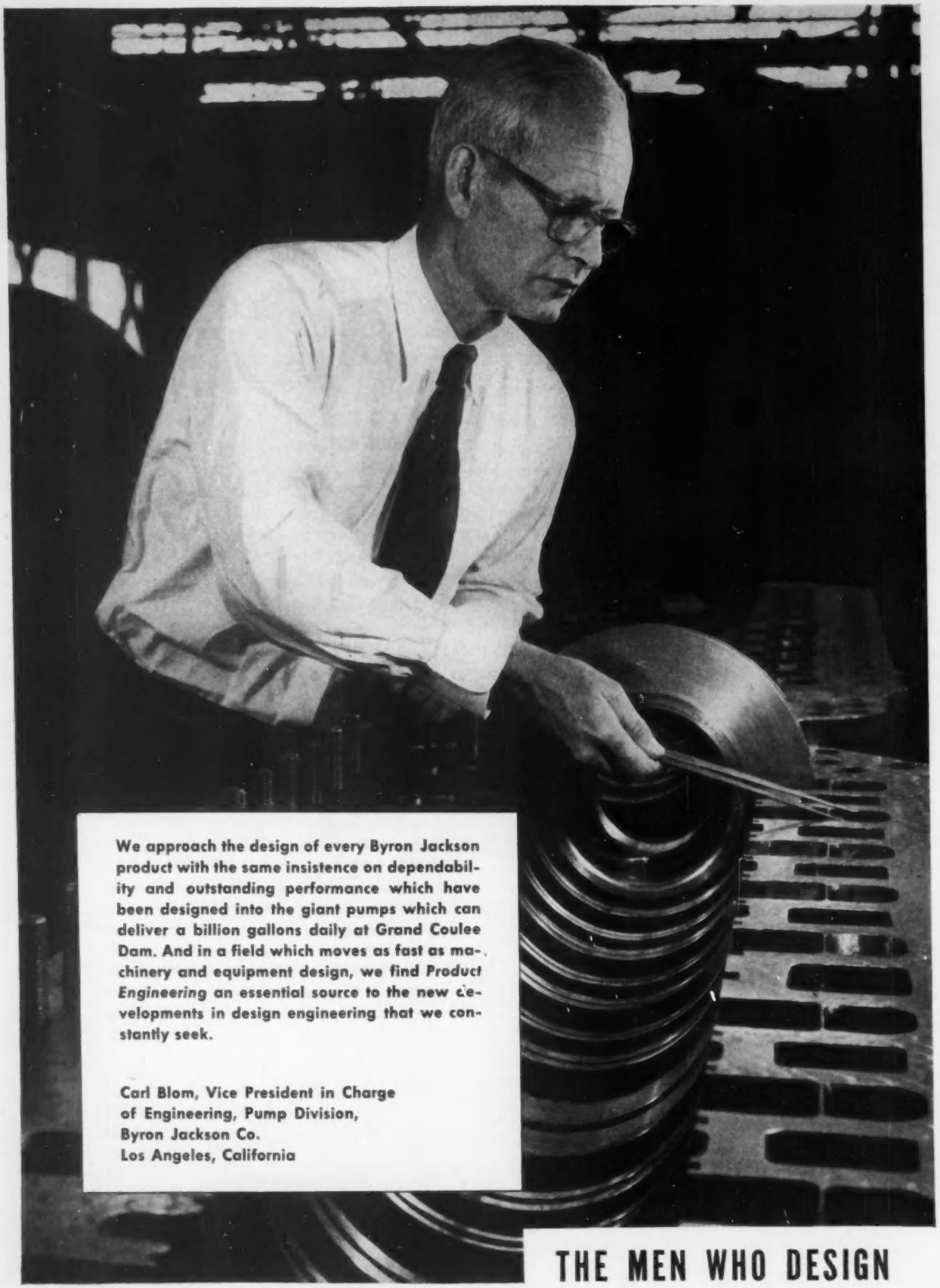
*Name* _____

*Title* _____

*Company* _____

*Street* _____

*City & State* _____



We approach the design of every Byron Jackson product with the same insistence on dependability and outstanding performance which have been designed into the giant pumps which can deliver a billion gallons daily at Grand Coulee Dam. And in a field which moves as fast as machinery and equipment design, we find *Product Engineering* an essential source to the new developments in design engineering that we constantly seek.

Carl Blom, Vice President in Charge
of Engineering, Pump Division,
Byron Jackson Co.
Los Angeles, California

## THE MEN WHO DESIGN

# He Leads Design at Byron Jackson

# HE READS PRODUCT ENGINEERING

**. . . *and when you want your advertising read* by industry's basic buyers of Original Equipment, you concentrate it in this No. 1 editorial and sales power of a $28-billion market**

Because the essential role design engineers play in the specification of parts, materials, components, and finishes was long ago accepted as fact, it is natural for original equipment suppliers to concentrate the great bulk of their advertising in design-engineering publications. And just as naturally, these manufacturers put far more of their advertising in *Product Engineering* than in any other design publication.

In the past 12 months, for example, *Product Engineering* has carried 1,044 *more* advertising pages than any other design magazine. The reasons why will suggest what *Product Engineering* can do to increase your products' sales in industry's great-growth market . . . and they all add up to unquestioned *leadership*.

With our May issue, *Product Engineering's* all-paid circulation passed 28,000* . . . which is *thousands more* than the free distribution other design publications offer you. And when you ask *why* so many of the men with whom you can most profitably do business pay to read *Product Engineering*, you find the basic reason for this magazine's great sales power.

That reason is *editorial strength and vitality*. The far-ranging, balanced, informative pages design engineering's biggest and ablest editorial staff put into *Product Engineering* not only attract the most design engineers . . . but even more importantly, they command the intent and responsive *readership* which alone gives your advertising its best chance to sell your products.

The more you study the facts, the clearer it is why *Product Engineering* has been the Original Equipment Market's No. 1 advertising medium for almost 25 years. We'll gladly put *all* the facts at your disposal any time you ask.

**Subject to ABC audit. ABC net paid, December, 1953 was 26,107*

**The McGraw-Hill Magazine**
**of Design Engineering**
**McGraw-Hill Building, New York 36**

DISTRICT OFFICES: Atlanta 3–Boston 16–Chicago 11
Cincinnati 8–Cleveland 15–Dallas 1–Detroit 26
Los Angeles 17–New York 36–Philadelphia 3
Pittsburgh 22–San Francisco 4–St. Louis 8

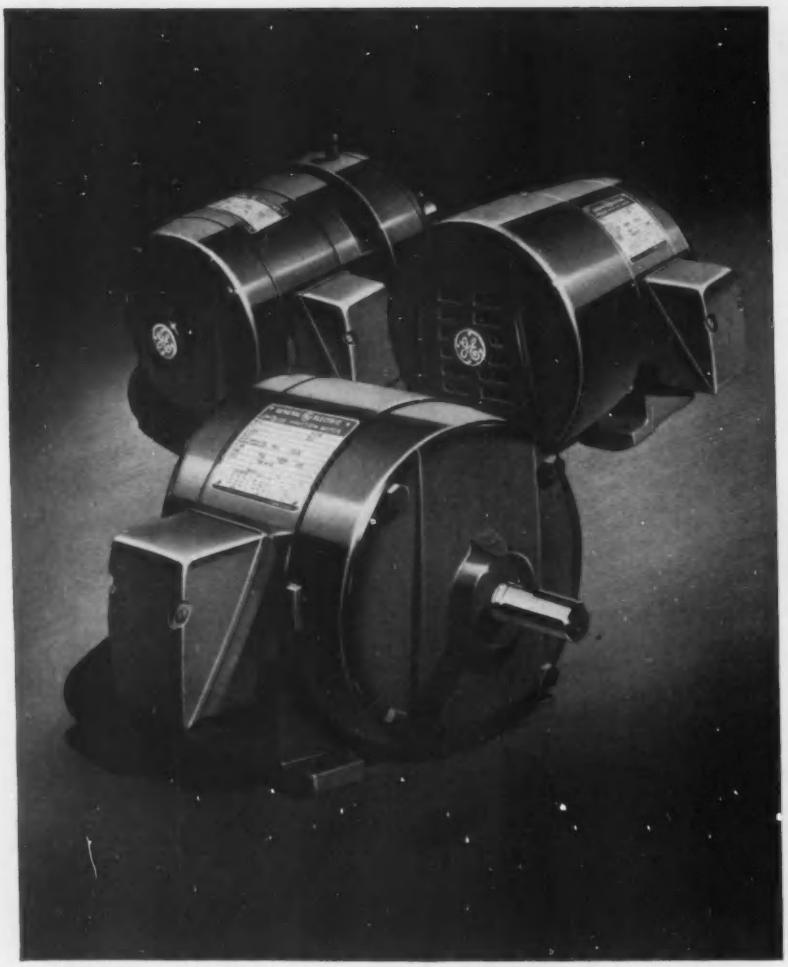
ABP ABC

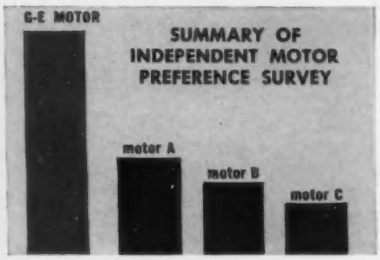
# AMERICA'S NEW PRODUCTS READ PRODUCT ENGINEERING

# Designer's

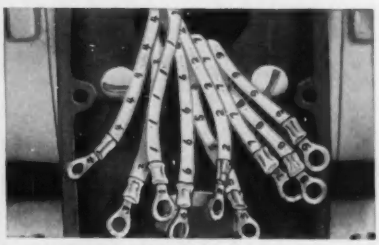
## Three good reasons for designing new TRI 55 CLAD motors into your machines

REG U.S. PAT OFF

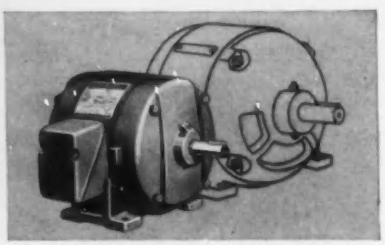





**1. BUYER PREFERENCE.** You take advantage of a 2 to 1 preference for the motors on your equipment when you use G-E motors. Buyers also like the G-E small motor service station plan (Bulletin GEC-972).



**2. EASIER INSTALLATION.** Perma-numbered leads are always easily read even when taped or clipped. Roomier conduit box has plenty of knuckle room. Bolts go in easily, quickly.



**3. MORE POWER PER POUND.** Lighter, smaller Tri/Clad '55' motor—in new NEMA frame sizes and ratings—reduces waste space, saves weight, lowers your handling, shipping costs.

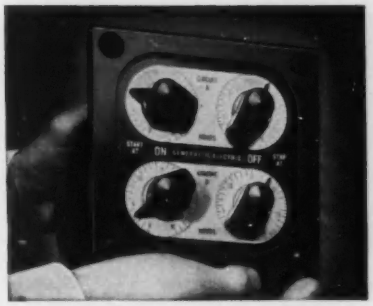
**MODERNIZE YOUR EQUIPMENT** with all-new General Electric Tri/Clad* '55' motors. A complete line assures you of getting the right electrical drive for your machine. Ratings in new NEMA 182 and 184 frames now available . . . entire line to 30 hp available soon. Check coupon for more information on Tri/Clad '55' dripproof, enclosed, and gear-motors.

*Registered trade-mark of General Electric Co.

GENERAL ELECTRIC

# Digest

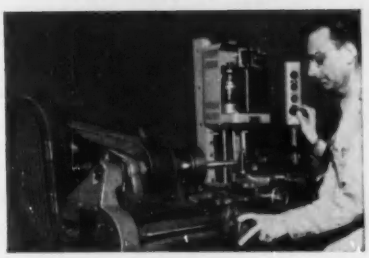
PRODUCT HIGHLIGHTS



## New TSA-18 process timer's small size helps simplify design problems

Accurate, adjustable time-delay opening and closing of electric contacts is provided by the new G-E TSA-18 process timer. With it, designers can add automatic timing to hydraulic presses, tire molds, baking equipment, heat-treating ovens, mixing machines, signals, conveyors, and others. The TSA-18's built-in auxiliary circuits permitting semi- or fully-automatic operation, and its compact size, only 5¾ in. square by 8$\frac{1}{32}$ in. deep, make it easily adaptable to a wide range of uses. Weighing only 6¾ pounds, it is easily installed. Bulletin GEC-1223.

## Compact Thy-mo-trol* drives give versatile speed control

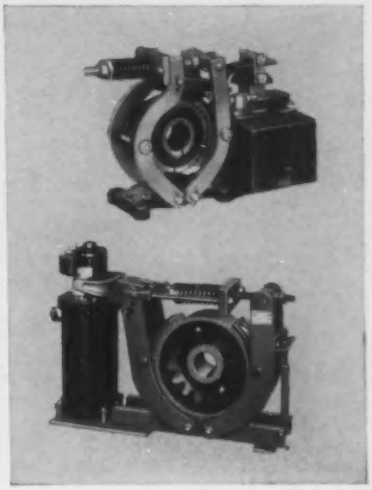


Specify G-E Thy-mo-trol packaged adjustable speed drives for almost limitless choice of speeds within the range. Speed ranges up to 100 to 1 or better are available in ratings from 1/40 to 30 hp. Components are: d-c motor, operator's control station, anode transformer for full-wave types, electronic control panel. Cabling and terminals are plainly marked for easy connection, and the system adapts readily to special drive requirements. It will increase from one operating speed to another in a fraction of a second, and has been service-proved on thousands of machines. Ask for Bulletin GEA-5337.

*Registered trade-mark of General Electric Co.

## General Electric a-c brakes give smooth, positive braking at low cost

When CR9516 solenoid and thrustor brakes are designed into machines they add markedly to customer acceptance. Braking torque is adjustable over a wide range. Self-aligning brake shoes help to give smooth, positive braking in either direction. Sturdy, simple construction contributes to its exceptional reliability. Both solenoid and thrustor types are available in three kinds of construction: open, dripproof, and watertight. Long lining life and long wheel life reduce maintenance costs. These G-E brakes are recommended especially for cranes, bridges, turntables, and conveyors, and in machine tool and other rotating-machine applications where continuity of service and low braking cost are important. A hand-operated device for releasing the shoe from the wheel is available in both types. Ask for Bulletin GEA-1518.



## Progressive Mechanization program widens market for your machines

General Electric's More Power to America Program "Progressive Mechanization" can help promote your machine sales because it is directed to your customers. The aim of this program is to show them how they can increase production and reduce costs through a progressive step-by-step mechanization of their operations. The program includes a manual and a color sound motion picture, "Motors in Industry," which dramatizes the importance of improved mechanization. For a complete description of the program, write for Bulletin GEA-5789. If you would like a showing of the film, call your nearest Apparatus Sales Representative.

**General Electric Co., Apparatus Sales Division, Section C668-115, Schenectady 5, N. Y.**

Please send me the following bulletins: √ for reference X for immediate project

- ☐ GEA-6012 Tri-Clad '55' Enclosed Motors
- ☐ GEA-6027 Tri-Clad '55' Gear-motors
- ☐ GEA-6013 Tri-Clad '55' Dripproof Motors
- ☐ GEC-972 Small-motor Service Station Plan
- ☐ GEA-1518 CR9516 AC Brakes
- ☐ GEC-1223 Process Timer
- ☐ GEA-5337 Thy-mo-trol Adjustable-speed Drives
- ☐ GEA-5789 Progressive Mechanization

**CONSULT YOUR SWEETS PRODUCT DESIGN FILE. You'll find "everything electric" for machinery manufacturers in the General Electric Section.**

NAME ..... COMPANY .....

CITY ..... STATE .....

## This Allen Cooler truck went right into our lab and proved . . .

# Why it pays to ask for

**G-E ENGINEERING** solved a complex truck refrigeration problem for Allen Cooler. The General Electric system provides uniform temperature when operating off the engine drive or on 115-volt AC plug-in during off hours. System was created by modifying standard G-E components, including an alternator, a rectifier, and two fractional-hp motors, and adding a regulator.

**1 PROBLEM PRESENTED** to G.E. by Allen Cooler design engineers called for flexible 24-hour truck refrigeration, maximum storage capacity, and minimum cost.

**2 RIGHT INTO G-E LAB** went this home delivery truck. Laboratory study indicated design requirements, helped cut time needed to come up with final electrical system.

# G-E motor application help

## G-E engineers design electrical system to provide low-cost truck refrigeration during deliveries . . . plus overnight plug-in service

If you have a difficult motor application problem, you'll find it pays to take advantage of the technical skills and the resourceful engineering of General Electric's Specialty Component Motor Department. Here's how Allen Cooler profited:

**Allen Cooler design engineers** wanted this: an electrical system for refrigerating milk delivery trucks which would operate at full cooling capacity at engine idling speed. An additional requirement was that the system also operate on 115-volt AC during off hours, thus providing 24-hour service. However operated, the system should maintain temperatures between 35 and 40 degrees at all times.

**G-E motor engineers** went to work on these specifications. They devised a packaged electrical system incorporating an alternator, a compressor-drive motor, an evaporator motor, a regulator, and a rectifier. Made up of these skillfully integrated components, the compact system provides reliable cooling with maximum truck-storage capacity.

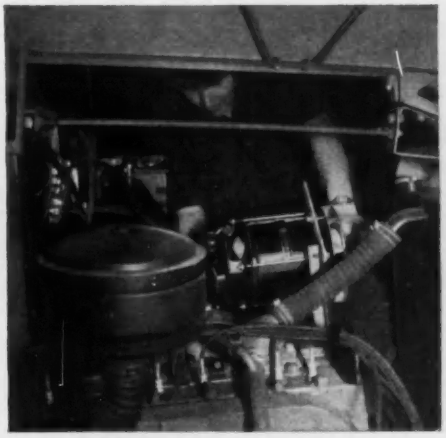
**Working closely** with the Allen Cooler engineers, General Electric engineers installed the packaged system in a dairy truck and tested it under actual operating conditions. The amazing performance: during 6000 miles of hot weather service, there was not a single operational complaint.

**Next time you have a** tough motor application problem, bring it to General Electric. You'll be taking advantage of engineering skills unmatched anywhere. To arrange for this service, contact your nearby G-E Apparatus Sales Office. For more information, write General Electric Company, Section 704-27, Schenectady 5, New York.

*Progress is our most important product*

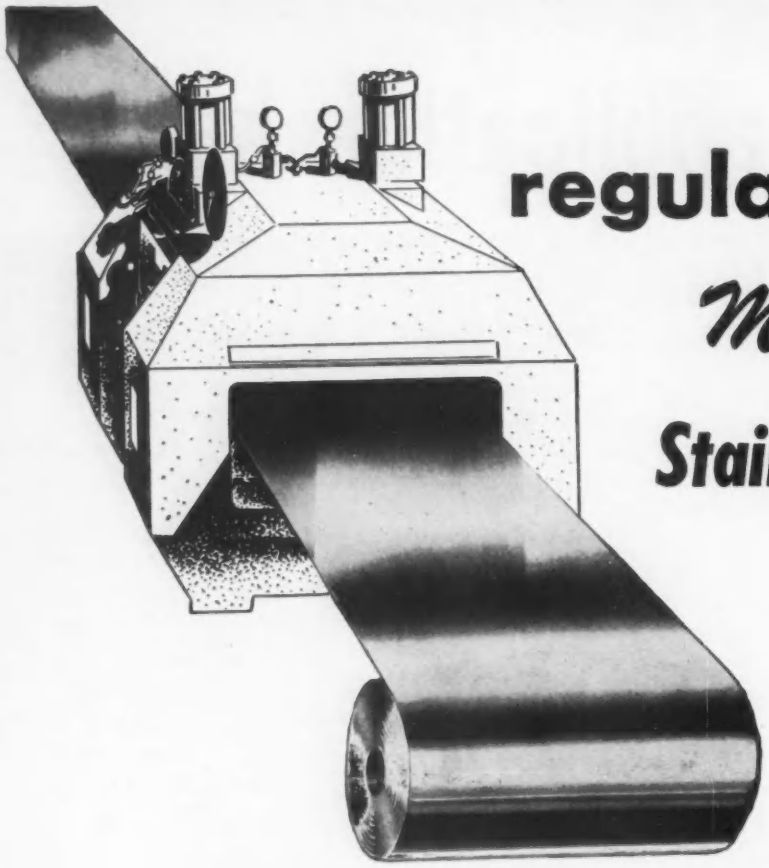
GENERAL ELECTRIC

**3 ACTUAL CONDITIONS** of operation were simulated. In this cell, temperature control accuracy was checked.



**4 INSTALLATION OF ALTERNATOR** under truck's hood. Unit must withstand heat, be compact, yet provide sufficient capacity.

**5 FINAL UNIT** uses minimum space, maintains even temperatures during deliveries, permits plug-in service.



# regular use of *MicroRold®* Stainless Sheets

# SAVES MONEY!

Stainless sheets are usually ordered by gauge number—with permissible A.I.S.I. thickness variation of plus or minus 10%—but are sold on a weight basis. Thus, you may order 18 gauge, needing about .0475" thickness, and receive .052" thickness. But MicroRold may be held to a 3% plus or minus tolerance; and you may order by gauge number, specifying that it be rolled on the "light side" of the gauge range. While these savings may not be apparent in every single sheet of MicroRold, the weights will average less than the theoretical when figured over a period of time. These savings can be substantial in your annual profit picture.

*Washington Steel*
CORPORATION
WASHINGTON, PENNSYLVANIA

# Perspectives

## DESIGN AND DEVELOPMENT

**GUIDED MISSILE PROGRESS**

Congress is demanding—and getting—another report on the status and the progress being made in the development of guided missiles. During hearings a few weeks back, the military gave confusing and conflicting statements to the House Armed Services Committee. Consequently, members of the Committee have demanded that Secretary of Defense Charles Wilson submit a report to them by the first of the year.

According to reports, Secretary Wilson is satisfied with the way things are going, but if the critical attitude of the Armed Services Committee is any indication, it is almost a certainty that an outside man will be brought in to do the evaluating. Moreover, it may also mean that another "Czar" will be brought in to ride herd on the $1-billion per year program once again.

**SERVICES IN COMPETITION**

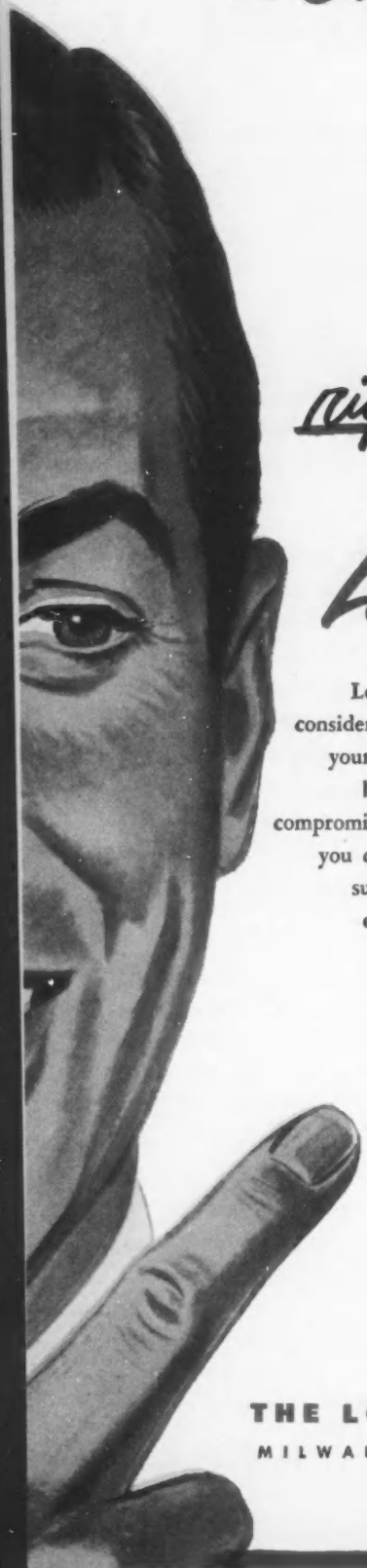
The advances that the Germans made in missile development during World War II showed how far we had lagged. The result since then has been an all-out rush to catch up and stay ahead of the crowd. As far as the Military is concerned, missile development has had about the highest priority of any military item. And, Congress has approved every request for funds. But there has been constant squabbling between the services in their attempt to take over the direction and control of the entire program of guided missiles from the other branches. The argument goes something like this: The Air Force claims that the missiles are "pilotless bombers"; the Army says that missiles are a "logical extension of field artillery"; Navy men are content to use both arguments, depending on which is to their immediate advantage.

**NEW SETUP NEEDED**

Back in October of 1950, K. T. Keller was appointed head of the missile program, and was made responsible to the National Security Council, reporting through Marshall, then Secretary of Defense. There is no doubt that Congress now feels that a similar Keller arrangement is needed to bring some semblance of order to the current program. While Keller's authority was then only "advisory", it is generally believed that he did much towards weeding out some of the less promising long-range research in the field. However, he made scant headway towards coordinating the programs of the Army, Navy, and Air Force, leaving the present situation. Keller finally left in 1953, and since then things have been settling back to their pre-Keller status.

The big difficulty of the missile program, though, is the continued pressure to push technical advances in all phases of the science of flight to the utmost—electronics, aerodynamics, and materials. To make matters

*(Continued on page 125)*



# A Complete adjustable speed line

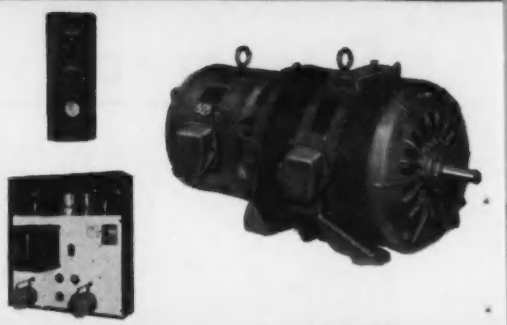
## Get the right answer from Louis Allis

It pays to think first of the Louis Allis Co. whenever you're considering adjustable speed drives for your product or plant. Louis Allis builds all basic types. There's no compromising — from this complete line you can select the unit that's exactly suited to your job conditions and engineered for your application.

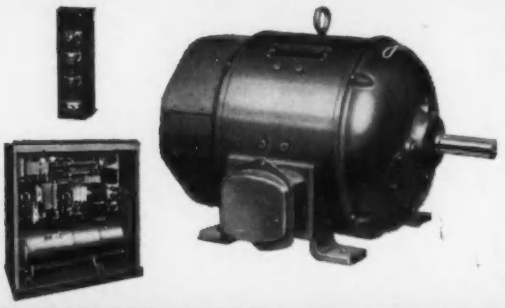
For the simplest — and best — solution to any adjustable speed drive problem, call your nearby Louis Allis Sales Engineer, or write to us.

**THE LOUIS ALLIS CO.**
MILWAUKEE 7, WISCONSIN

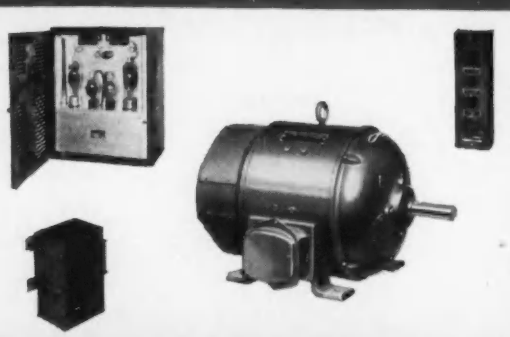
ASD-101



✓ **AJUSTO-SPEDE.** ½ to 75 horsepower. A versatile eddy current clutch combined with a constant speed AC squirrel cage motor provides wide, continuous duty speed ranges. Tachometer feedback circuit offers precise speed regulation in an unusually compact drive. Many optional features available — dynamic braking, torque control, threading speeds, inching, jogging, multi-motor operation and range drives.



✓ **SELECT-A-SPEDE.** 5 to 200 horsepower. New magnetic amplifier and adjustable voltage control provide superior speed regulation — better than required on most machines — from ⅛ base speed or less to full base speed. All-electric circuits — easily serviced. A.C. source, connected to D.C. by motor-generator set, drives adjustable speed D.C. motor. Many special control features available — reversing, dynamic braking, jogging, special programming or sequencing control, extra wide speed range. All drive motor enclosure available.



✓ **NEW! ELECTRONIC SELECT-A-SPEDE.** ¼ to 15 horsepower. D.C. adjustable speed drive motor operates from A.C. electronic power unit. Infinitely adjustable speed ranges 5:1, 20:1, 50:1, 100:1 available. Unusually close speed regulation to ½% with optional tachometer feedback circuit. Included as standard are: dynamic braking, torque limit, line voltage compensation. A few available modifications include: reversing, jogging, threading, and quick slow-down. All motor enclosures and control stations — from open to explosion-proof.

worse, it all is being conducted under a blanket of secrecy, making it difficult for congressmen to accurately evaluate the situation. It also makes it possible for the services themselves to hand out press releases and pictures that give a completely colored picture of the state of the art.

**TWO MISSILES**

The two most talked about guided missiles are the Air Forces Matador "pilotless bomber", and the Army's "anti-aircraft" Nike. But according to reports, neither of these is close to satisfactory to the services that have them, despite the fact that Matador squadrons are now in Europe, and Nike batteries are now being set up around a dozen or so of our major cities. In the first public demonstration of the launching of the Matador, the missile dropped into the sea; the second flew correctly. The Army, too, knows that its Nike will not fly high enough or fast enough for present day planes. And in other essential respects, it is not completely satisfactory.

**NEW HIGH PRIORITY PROGRAM**

In Washington there has been a complete reversal in the thinking on another high priority program—that is, the development of the atomic airplane. Not long after Secretary Wilson and his group took over, about 18 months ago, they threw cold water on the talk about early development of any aircraft powered with an atomic engine. This was based on the conclusion that the whole idea was too far in the future to really get excited about. Now, there has been renewed talk about flying an atomic plane in five years, not ten, as originally figured. To back this up, there has been a step-up in interest and funds being spent to get a plane in the air, even though the first one that flies may not be of any use as a tactical or strategic weapon. However, if any guess were to be made on this score, the chances are that a strategic bomber will be the first nuclear powered plane. Earlier plans were that it might be one of the nature of Howard Hughes' huge flying boat.

As before, secrecy restrictions are such that only small bits of information are allowed to be published. But of interest is one new development concerning the placement of a contract with a company which up to now has not been included in the program.—Glenn L. Martin. To date, engine development has been in the hands of Pratt and Whitney and General Electric, with Boeing and Convair responsible for the airframe design. Total expenditures on the entire project have been running around $14-$16 millions per year—so far.

**DESIGN PROBLEMS**

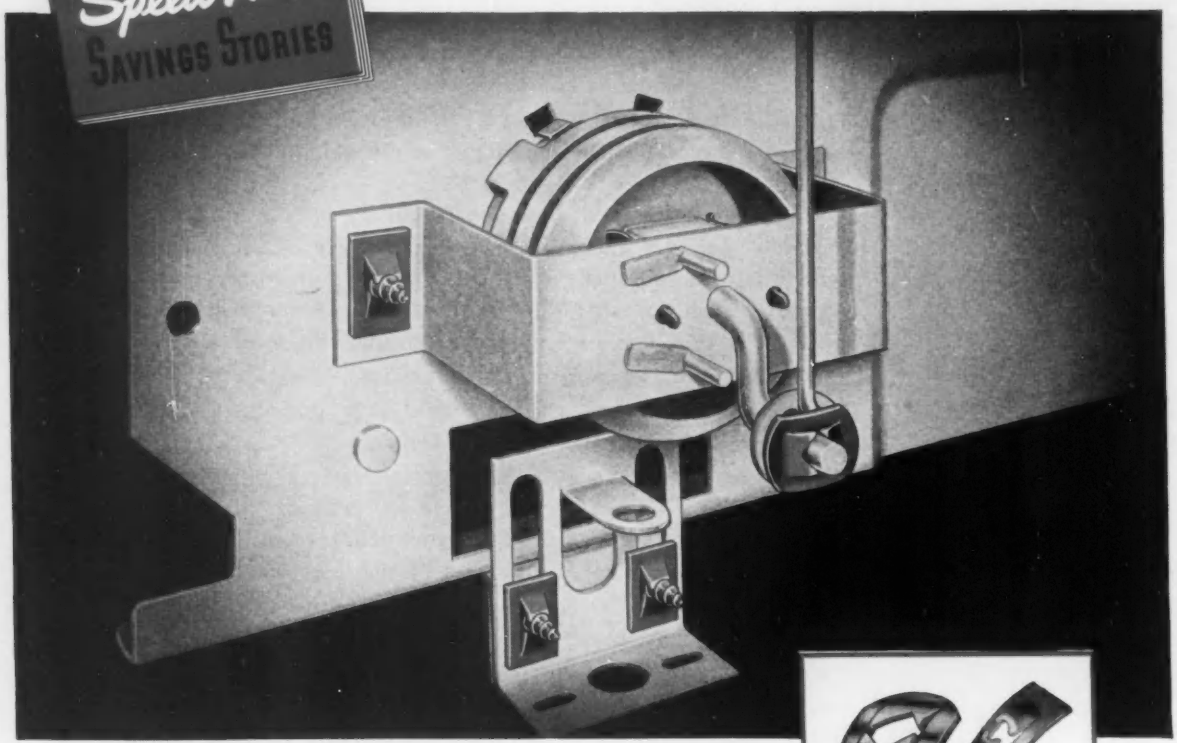
Some of the design problems that have been harassing the engine makers are these: (1) Whether one or two separate circuits will be needed to carry the heat from the atomic firebox to the jet heating chamber. Since radioactive material is also transferred, two circuits may be required to cut down the amount of contaminated air exhausted over the countryside; (2) Whether the lines used to carry the heat transfer agent are to be made of metal or some other material. High temperatures and radioactive material have lead to considerable research in ceramics as a possible out.

TINNERMAN

Speed Nut®

SAVINGS STORIES

FASTEST THING IN FASTENINGS®



# Chrysler Airtemp enjoys "refreshing" 40% cost saving!

## New Casement Window Air Conditioner assembled at lower cost with 27 SPEED NUTS

Engineers of Chrysler's Airtemp Division, Dayton, Ohio, accepted many of the cost-saving recommendations in a Tinnerman Fastening Analysis Survey on their new Room Air Conditioner for casement windows. This led to the selection of 11 different types of SPEED NUTS to make a total of 27 attachments. The result: an estimated 40% saving in assembly costs over alternate fastening methods!

In addition to the Push-On and Flat Type SPEED NUTS used in the control panel assembly illustrated above, other SPEED NUT brand fasteners provide lightning-fast, corrosion-free, vibration-proof attachments on other sections of the new unit.

A Fastening Analysis of your product can lead to lower costs on current models, even greater savings on new or advanced designs. See your Tinnerman representative for complete details!

Push-on Speed Nut | Flat Type Speed Nut

SPEED NUT applications result in substantial savings in assembly time, cost of materials, and materials handling. For example, SPEED NUTS eliminate costly threaded inserts, make faster, easier attachments in blind locations, and permit greater design flexibility. A complete range of types and sizes available.

Write today for your copy of the new Tinnerman Fastening Analysis Service Bulletin Number 336: TINNERMAN PRODUCTS, INC., BOX 6688, Dept. 12, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners, Ltd., Hamilton, Ontario. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine).

TINNERMAN Speed Nuts®

MORE THAN 8000 SHAPES AND SIZES

# Start the Ball Rolling

NUMEROUS LETTERS commenting on the editorial "Standards Without Worth" have been received. All the writers are strongly in favor of the proposal set forth in the editorial, namely, that the arbitrary gage number systems for designating strip and sheet thicknesses, wire diameters, drill sizes and screw sizes be abandoned. Apparently it is only necessary to get a movement started in this direction. Its wide acceptability will then result in an early elimination of the clumsy and confusing gage number systems.

There are many organizations that are interested in and concern themselves with the development and adoption of standards of all kinds. The problem of gage number systems is logically in the field of interest of the machine design division of the American Society of Mechanical Engineers and that of the American Society for Engineering Education. Both those groups would perform a great service if they were to recommend the elimination of the use of gage numbers for the designation of sizes.

The Society of Automotive Engineers and the American Society for Testing Materials are two more organizations that are concerned in this problem. It is perhaps significant that in the ASTM tables for the tensile requirements for the strength of wire, the wire diameters are expressed in inches, not gage numbers. And naturally so because the gage number in itself has no significance.

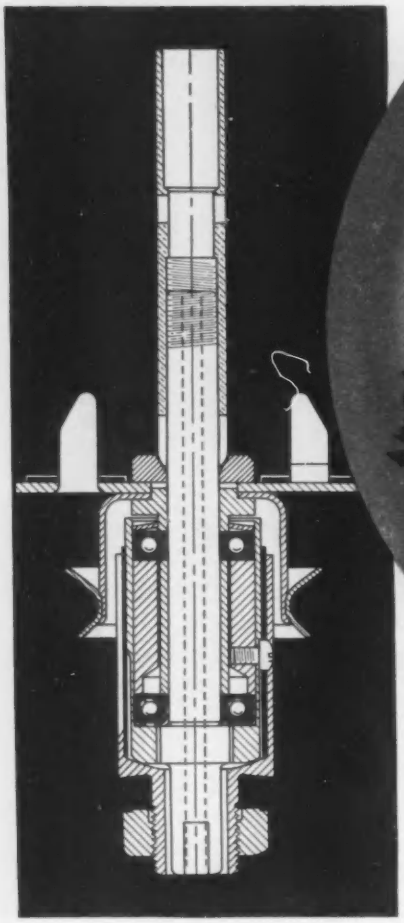
Indeed, there are wires produced commercially in considerable quantities for which there are no gage numbers. The diameters of these wires are always, and can only be, expressed in inches. ASTM specifications of "Dimension and Permissible Variations" require that "The wire sizes shall be expressed as the diameter of the wire in decimal fractions of an inch."

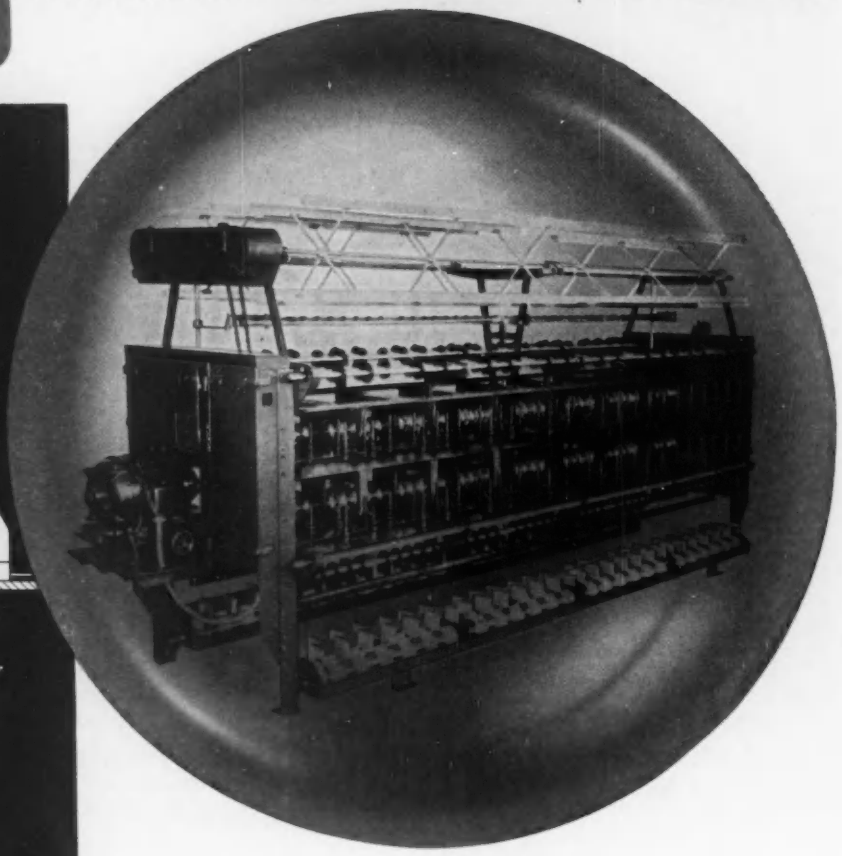
The final step in the establishment of a national standard is through the American Standards Association. This association takes action only at the behest of other societies or associations. It does not initiate standards; it supervises their establishment when requested to do so by authoritative organizations.

Here is a project that can well be launched by the machine design division of the ASME or ASEE, by the SAE, ASTM. All that is necessary is for individuals in those groups to speak up for the elimination of gage numbers. Now is the time to start the ball rolling.

George F. Bodenhott

# "TOPS" IN TEXTILE APPLICATIONS





Arnold Rubber Covering Machines use two New Departure **ball** bearings in each spindle . . . reach speeds of 10,000 r.p.m. with only 5 h.p. needed for each 80-end machine.

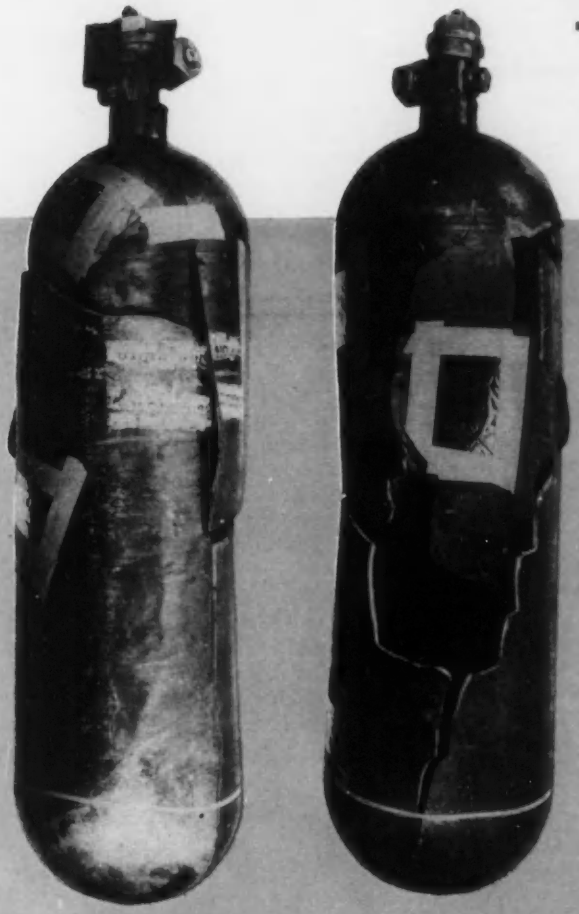
High spindle speeds with low power requirements . . . high precision with low upkeep. These are some advantages New Departure **ball** bearings bring to Arnold Rubber Covering Machines.

Throughout the textile field, New Departures assure better, faster machine operation with lower power, lubrication and maintenance costs. And better-quality finished products result.

When you have textile equipment in the design stage, *talk with your New Departure engineer.* He'll be glad to help you get greater efficiency and economy in your bearing applications.

**NEW DEPARTURE**
**BALL BEARINGS**

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
Plants also in Meriden, Connecticut, and Sandusky, Ohio
In Canada: McKinnon Industries, Ltd., St. Catharines, Ontario



Static and overload fractures, fatigue fractures and stress corrosion cracking are the most common types of service failures. Twelve examples show service failures caused by: use of the wrong material, decarburization that reduces strength, fretting between parts and other causes. Also included are some precautions that should be considered in the design, fabrication and use of metal parts to reduce service failures.

J. A. BENNETT
Chief, Mechanical Metallurgy Section
G. W. QUICK
Metallurgist, Mechanical Metallurgy Section
National Bureau of Standards

*An aircraft oxygen cylinder exploded because it was made from steel much harder than that specified. Use of the wrong material is one reason . . .*

# . . . WHY PARTS FAIL

MECHANICAL FAILURES of metals can be broadly classified as those in which the part: a) deformed to such an extent that it was no longer serviceable; or b) fractured. Since the fracture of a part is often more disastrous than excessive deformation, emphasis is placed upon failures by fracture. But rarely does a structure or machine fail in normal service simply because loads are greater than the strength of the parts. Occasionally this will happen if service requirements are underestimated, as in the example of the bolts shown in Fig. 1 which failed because decarburization of the surface decreased the strength of the threads. Much more common, however, are failures where factors other than static loading of the parts are involved, such as fluctuating stress, corrosion, and rubbing between supposedly fixed members.

The nature of the stresses, and other factors,

## PREVENTING FAILURES

*Product Engineering* published a series of five articles in 1949 by Charles Lipson that discussed the factors affecting the strength and life of machine parts. These articles evaluated such factors as: static, alternating and combined loadings on the use of parts; surface finishes, plating processes and cold working on the fabrication of parts; and stress concentration and reentrant angles on the design of parts.

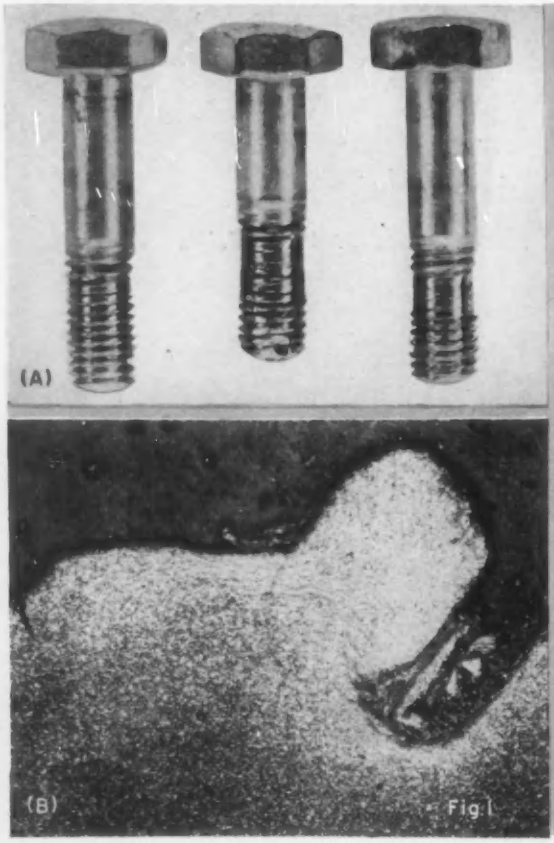
The fact that many service failures of the same type still occur indicates that the basic cause of failures and the precautions needed to avoid them are not fully understood or realized by those directly concerned. This article, based on cases investigated by the Metallurgy Division of the National Bureau of Standards, considers several types of common service failures—static or overload fractures, fatigue fractures and stress corrosion cracking. Since the cause of failure can often be determined by an examination of the actual fracture, photographs of the actual failures are included.

But more important, these examples serve to emphasize the precautions that must be taken in the design, fabrication and use of metal parts for structures and machines. These include such items as: in design, to reduce sharp re-entrant angles; in fabrication, to avoid stress risers; in use, to restrict the loads to the design values.

The editors wish to thank the staff of the Metallurgy Division for allowing Product Engineering to publish some of the more interesting cases from their files. Additional information will be available with the publication of the National Bureau of Standards Circular 550, "Mechanical Failures of Metals in Service".

have a marked influence on the nature of a fracture, so a knowledge of the several types of fractures provides a powerful tool in determining the causes of failures in service.

*Static or Overload Fracture.* When a metal member fails because of a single application of a load greater than the strength of the member, there is usually considerable plastic deformation prior to fracture. This deformation is apparent on inspection of the fractured parts; for instance, Fig. 2 shows the large amount of bending that occurred in a landing gear part prior to fracture. This ability of a member to withstand plastic deformation is a function not only of the properties of the material but also of the geometry of the member, the type of stress to which it is subjected, the rate of loading, and, in many materials, the temperature. As an example, Fig. 3 shows the effect of geometry on the ductility of steel; these two specimens are made of the same steel and both were originally the same shape. Both were loaded in the same



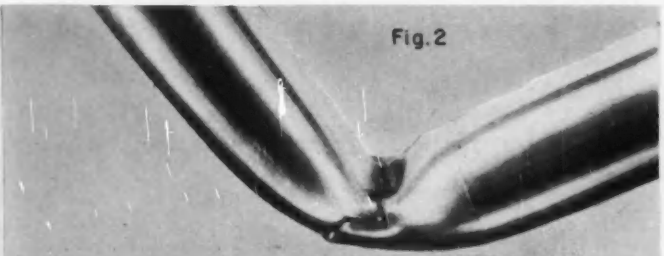




Fig. 1—(Left) The threads of these steel aircraft bolts had stripped before the recommended torque values were reached, (A). The bolt surfaces had been decarburized during fabrication or heat treat, (B). This decreased the thread strength so that they deformed in shear under the normal applied load.

Fig. 2—(Above) Landing gear retracting strut made from chrome plated steel. The tubular member, originally straight, bent about 75 deg before final fracture. Extent of plastic deformation can be seen by the checks in the chromium plating. This is characteristic of fractures caused by overload.

Fig. 3—(Right above) Laboratory specimens of two steel bars. Identical bars with a notch in one side were loaded by supporting the ends and striking the middle with a heavy pedulum. The upper specimen was struck on the side opposite the notch; the lower on the side containing the notch.

way: by supporting the ends and striking the middle with a heavy pendulum. The lower specimen was struck on the side containing the notch and was deformed a large amount but did not fracture. The upper specimen was struck on the side opposite the notch and broke in a brittle manner with relatively little plastic deformation.

Although there are very few applications of metals in which it is necessary for the part to deform appreciably in service, some ductility is essential to permit yielding of the metal at sharp notches. Such notches are almost universally present in commercial metals due to inclusions, bolt holes, welding defects, scratches, corrosion pits and other reasons. The stress at the bottom of a severe notch may be several times as large as the average stress on the section; a ductile material will deform plastically in the small highly stressed region and so redistribute the stress that its peak value will be reduced. If conditions are such that the material behaves in a brittle manner, a crack will be formed before plastic deformation can take place. Frequently, this crack will propagate at high velocity through the rest of the section. This type of fracture is characterized by very little deformation adjacent to the fracture and often by markings known as "herringbone" or "chevron" patterns on the fracture surface. Fig. 4 shows a fracture of this kind produced in the laboratory. It will be noted that the pattern points toward the source of the fracture. This fact is often of value in studying service fractures.

The lead photo shows a cylinder which failed because the excessive hardness of the steel caused it to have inadequate ductility, while the fracture of Fig. 5 was caused by the poor transverse ductility of steel containing large inclusions.

The strength of metals generally decreases as the temperature increases. Consequently, parts that have adequate strength at room temperature may fail if the operating temperature becomes high, and the fracture can occur after many hours under constant load. If the temperature is high enough, the strength of the grain boundaries in the metal will be reduced to such an extent that intergranular cracking will occur, and the resulting fracture will show very little ductility. Fig. 6 is a fracture of this type.

*Fatigue Fractures.* When a metal is subjected to repeated or fluctuating loads it may eventually fracture at stresses much lower than those which would be required to cause fracture under static conditions. This phenomenon is known as fatigue and is the most common cause of primary failures of metals in service. Laboratory tests have established the fact that a fatigue fracture is progressive in nature; after a number (often many million) of cycles of stress, a small crack forms in the region where the stress is highest. Under continued stressing, this crack grows in a direction generally perpendicular to the tensile stress until the cross section of the member is reduced to such an extent that the remaining area fractures from overload. Because of this mechanism, the

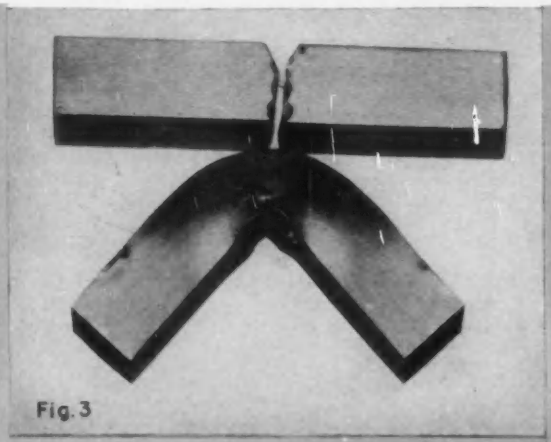


Fig. 3

Fig. 4

**Fig. 4—(Left below) Fractured surfaces of a laboratory tested specimen. The specimen broke by tearing from the root of a saw-cut notch (smooth area). Herringbone or chevron pattern will usually point towards the source of the fracture.**

**Fig. 5—Failure of a part made from free-machining steel. Tensile stress was applied in a transverse direction. Woody appearance is caused by the inclusions in the steel. To avoid this type of failure, forgings should be used.**

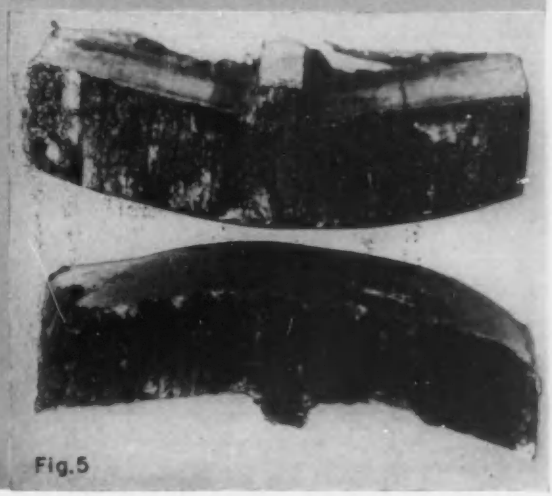


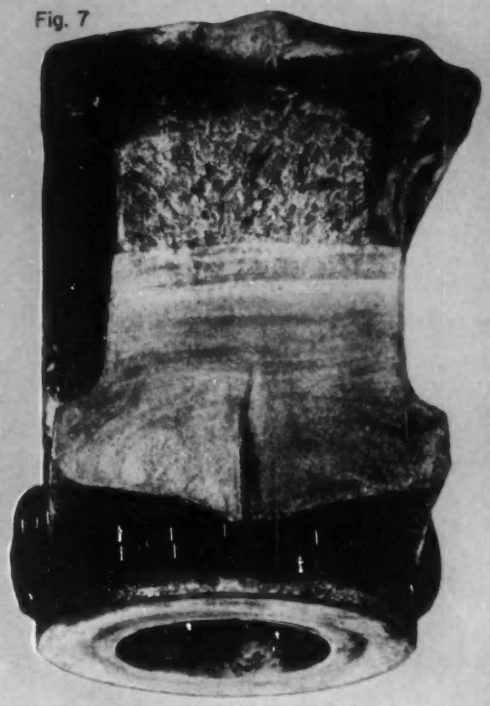
Fig. 5

Fig. 6

Fig. 6—Brass aircraft turnbuckle that had broken while heated to a high temperature. Fracture surface shows extremely coarse grains and little ductility. The temperature at failure was sufficiently high to reduce the strength of the grain boundaries in the metal.

Fig. 7—Front axle of forged steel that failed in fatigue. Crack originated near the middle of the bottom of the part. More than half the cross section was cracked before the remaining portion failed from overload. Crack originated at point where forging flash was removed.

Fig. 7



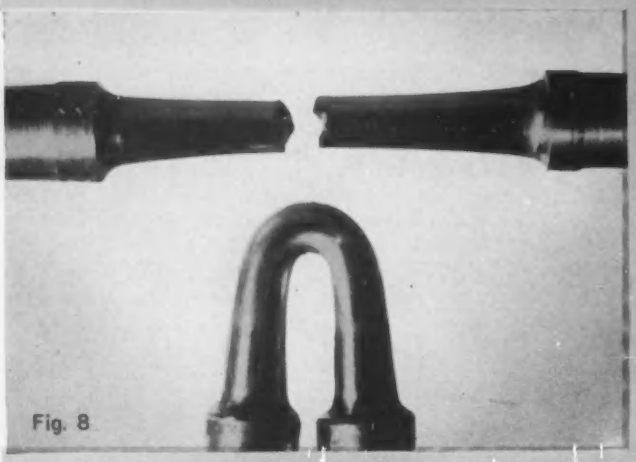


Fig. 8

Fig. 8—Effect of repeated stress on ductility. Identical specimens were loaded in bending. The upper one was subjected to many cycles of reversed loading and failed with a typical fatigue fracture, showing no ductility. A single high load was applied to the lower specimen causing only bending of the part.

surface of such a fracture shows two characteristic regions that are usually quite different in appearance. This is clearly shown in Fig. 7, where the area of the fatigue fracture at the bottom can be seen to be much smoother than the overload fracture portion at the top.

Because the stress required to initiate a fatigue crack is usually less than that needed to cause plastic deformation of the metal, a fatigue fracture is characterized by its brittle nature. Fig. 8 shows this effect demonstrated with laboratory specimens. In most fatigue fractures that occur in service the fatigue crack extends only part way across the section, and there is a considerable area broken by overstress. This part will show some ductility, so fractures of this type will not fit together well when the parts are replaced in approximately their original relationship (the fatigue crack portion will be held apart by the deformed overstress portion).

The surfaces of fatigue fractures frequently show characteristic markings known as "beach" or "clam-shell" markings, which represent the outline of the fatigue crack at various points in its growth. When these markings are present, Fig. 9, they provide a means of locating the origin of the fracture accurately.

It is generally agreed that the primary factor responsible for the fatigue failure of a part is much more often its geometry than the material of which it is made. A large percentage of the failures investigated could have been avoided by more careful design to eliminate points of stress concentration. The stress necessary to cause fatigue failure is usually less than that required for plastic deformation of the metal, so there is no opportunity for redistribution of the load in the neighborhood of the notch. The failure of Fig. 10 was caused by the inadequate fillet at the cut-out for the hold-down nut. Similar failures have been investigated almost every year; the frequent occurrence of such easily

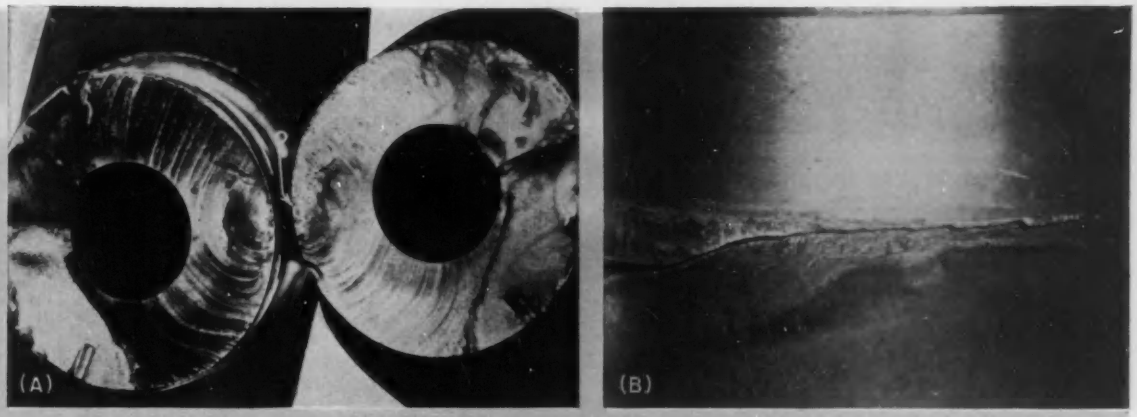



Fig. 9—Fatigue failure of an alloy steel engine crankshaft. Beach or clam shell markings show the way in which the fatigue crack progressed across the shaft, (A). Fracture started at point O in an area where fretting had occurred under the propeller hub. (B), shows the extent of the crack under the hub. Final failure caused by overload.

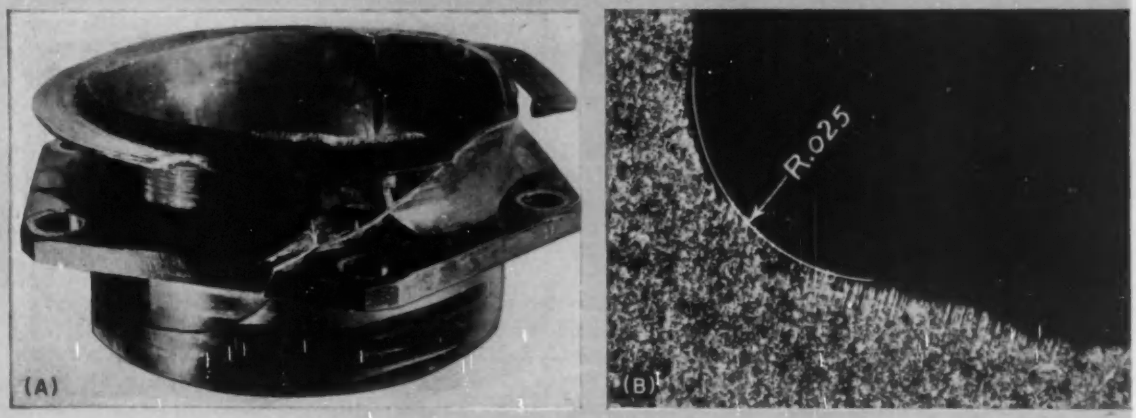



Fig. 10—Steel engine cylinder fatigue failure caused by a stress concentration at the cut-out for the hold down nut. Fatigue started at arrow, (A), and progressed first diagonally, then circumferentially. Section through intersection of cut-out and cylinder wall, (B), shows sharp corner radius which is a cause of stress concentration.

avoided failures indicates that there is not sufficient emphasis on fatigue in the design and fabrication of equipment subject to fluctuating loads.

Fretting caused by rubbing between closely fitting members is a frequent source of fatigue fractures which does not seem to be properly appreciated. The failure of Fig. 9 was initiated in this way. When fretting is severe between steel members it can often be detected by the presence of a fine brown powder. This should always be regarded as a danger sign and corrective action should be taken if the parts are subjected to fluctuating stress. A powder, usually black, is formed by fretting between aluminum members.

As most fatigue fractures start on the surface, the condition of the surface is of primary importance if fatigue failures are to be avoided. Decarburization of the surface of a steel member, for example, reduces the fatigue strength to that of a similar member having low carbon content throughout. Defects of the surface such as tool marks, scratches, corrosion pits, are far more damaging to the fatigue strength of a part than to its static strength.

The effect of differences in material caused by oxide inclusions, on the nature of a fatigue fracture is illustrated by Fig. 11.

Fatigue fractures are often erroneously blamed on "crystallization" of the metal. Since all structural metals are crystalline from the time they solidify from the molten state, the term "crystallization" in connection with fatigue is meaningless and should be avoided.

*Stress Corrosion Cracking.* When a metal is exposed to a corrosive media and is subjected to a load, fracture may occur even though the stress is less than that required to cause fracture in the absence of corrosion. The corrosion necessary to initiate stress corrosion cracking need not be severe, and frequently will not cause noticeable corrosion on the surface. In many instances this type of fracture can oc-

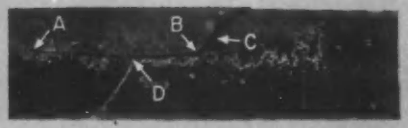



**Fig. 11—Fractured steel torsion rod from a highway bus. The fatigue crack started on a longitudinal plane which is characteristic of fracture under torsional load. This crack extended from A to B, then a tensile fatigue crack formed at the end of the longitudinal crack and extended to C. Final overload fracture of the rod followed a helical path from C around the rod to D, causing complete failure.**

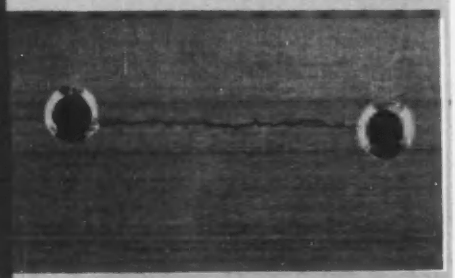


**Fig. 12—Square aluminum alloy tubing that developed cracks while in service. Crack resulted from a combination of very high internal stress and mildly corrosive conditions. Internal stress resulted from method of fabrication. Crack has progressed to left beyond hole drilled to forestall its spread. The meandering nature is characteristic of stress corrosion cracking in aluminum alloy.**

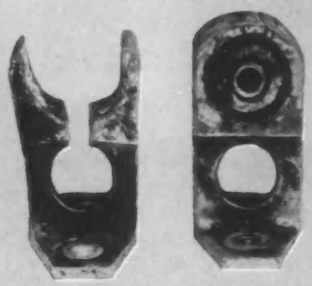


**Fig. 13—Stress corrosion cracking of a 24S aluminum hinge fitting. Failure probably caused by forcing an oversized bearing into fitting. Such a force fit can cause tensile stress of sufficient magnitude to crack a material which is susceptible to intercrystalline corrosion. Fitting on left has lost its bearing while one on right has merely cracked along top surface.**

cur in parts that are subjected to no external load whatsoever, due to the internal stress developed in the part during fabrication, Fig. 12.

This is also a progressive type of fracture, beginning with a small crack and progressing across the section perpendicular to the tensile stress. The resulting facture is brittle, as stress corrosion cracking can occur under stresses less than those required to cause plastic deformation. If differs from a fatigue fracture in that there are usually numerous cracks that tend to "wander" through the metal, giving a coarse appearance to the fracture surface. A polished section through the metal damaged by stress corrosion cracking usually shows a network of fine cracks.

Corrosion is frequently a contributing factor to mechanical failures. A small corrosion pit can concentrate the stress in the surface of a part and be dangerous if the part is subjected to fluctuating loads. Even corrosive agents that do not appreciably corrode the metal can effect its fatigue strength. Some light metals and copper alloys are found to give trouble under mildly corrosive conditions and care should be taken to avoid the possibility of stress corrosion in the use of these materials. Preventive measures in the selection of materials will minimize these effects.

An example of stress corrosion cracking, illustrated by Fig. 13, was caused by the stress in a press-fitted assembly.

These examples serve to emphasize the precautions which must be observed by everyone concerned with the design, fabrication or use of metal parts in order to avoid failure in service.

Some of these precautions are:

1. Design: Elimination of sharp reentrant angles at fillets, keyways and other changes of section. Accurate stress analysis at points of stress concentration and verification of the analysis by experiment or by fatigue testing of sample parts. Careful selection of material and fabricating methods to produce parts of adequate transverse strength if significant stresses are to be applied in that direction. Proper combination of material and static design stress to eliminate the possibility of stress corrosion cracking in the environments to be met. Specification of materials that will provide adequate resistance to brittle fracture, particularly under shock loading and low ambient temperatures.

2. Fabrication: Careful workmanship to avoid points of stress concentration caused by welding defects, tool marks, improperly formed fillets, grinding cracks, quenching cracks and others. Control of forging practice to avoid folds, seams, and internal fissures. Protective atmospheres during heat treatment to avoid decarburization. Proper control or elimination of residual stress caused by pressfits or cold working in parts subject to corrosive environments. Rigid inspection of highly stressed parts to eliminate surface imperfections.

3. Use: Control of operations to restrict the loads to those for which the machine or structure is designed. Protection of parts from corrosion that can cause damage. Periodic inspection of highly stressed members by personnel acquainted with the nature of fatigue failures. Prompt repair or replacement of parts damaged by unusual conditions, such as fire, collision, overloading or unusual corrosion. Periodic disassembly of clamped members to inspect for evidence of fretting.

*Acknowledgments*—The authors are indebted to the following agencies for permission to use material in reports submitted to them. Office of Aviation Safety, Civil Aeronautics Administration; Bureau of Safety Investigation, Civil Aeronautics Board; Bureau of Aeronautics, Department of the Navy; Bureau of Motor Carriers, Interstate Commerce Commission.

## REFERENCES

1. Prevention of the Failure of Metals Under Repeated Stress, by the Staff of Battelle Memorial Institute under the direction of Dr. H. W. Gillett, John Wiley & Sons, 1941.

2. Why Machine Parts Fail, by Charles Lipson, Machine Design, May to December, 1949.

3. Interpretation of Service Fractures, by R. E. Peterson, Chapter XIII of Handbook of Experimental Stress Analysis, John Wiley & Sons, 1950.

4. Aircraft Design Through Service Experience, Civil Aeronautics Administration Manual No. 103, Sept. 1953.

5. Investigations of Structural Failures in Welded Ships, by M. L. Williams and G. A. Ellinger, Welding Journal, 32, 498s, Oct. 1953.

6. The Tool Steel Trouble-Shooter, Bethlehem Steel Co., Handbook 322, 1952.

7. Mechanical Failures of Metals in Service, National Bureau of Standards, Circular 550 (in press).

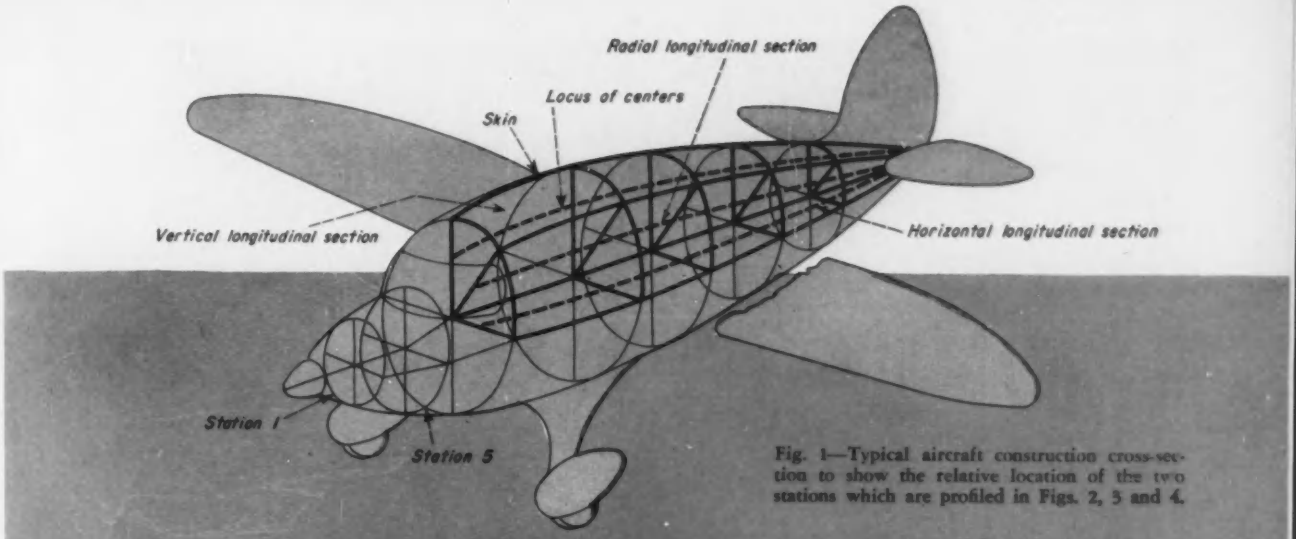



Fig. 1—Typical aircraft construction cross-section to show the relative location of the two stations which are profiled in Figs. 2, 3 and 4.

# Single-Curvature Technique Speeds Body Profiling

G. M. KELLEY
The De Havilland Aircraft of Canada, Ltd.

METHODS FOR DEVELOPING both double and single-curvature surfaces are continuously under study by most aircraft companies in attempts to speed up what generally are meticulous and costly time consuming operations. Several techniques have been used with various degrees of success. One method is to define cross-sections entirely in terms of tangent radii. Another method is the mathematical lofting technique which controls aircraft lines through a specialized use of the second-degree curve. The latest method aimed at lofting simplification is a single-curvature approach for aircraft fuselage components that can be described as segments of cones having their radii in the plane of the paper.

Equally adaptable to other applications whose cross-sections primarily stress utility form, the single-curvature technique offers several advantages for its use: (1) Accelerates the precise final lofting and template drawing phases in conventional aircraft; (2) Facilitates the preliminary and tentative design lines for original study or mock-up; (3) Simplifies the design of such items as vertical and sliding windows to allow them to move regular to the surface instead of in elaborately constructed tracks. From the manufacturing viewpoint, this technique results in the elimination of costly skin forming dies with less time being required to produce a part. Also, the single-curvature skin can be profiled and pierced in the flat before forming. When extended to cover oval, obround and rectangular sections, this technique points up additional advantages beyond those obtained by the conventional single-curvature surface generated between either calculated second-degree or faired sections.

*Outline Design Obstacles.* First step in the generation of a single-curvature skin is to select a convenient working scale and then phantom in the various design obstacles about the horizontal and vertical axes of the aircraft. After allowing for such items as engine and accessory clearances, pilot's shoulder clearance, visibility angles, and cabin cargo space, the envelope profiles can be roughly drawn about the axes. Fig. 2 illustrates this initial phase of the lofting operation.

*Determine Character of Envelope.* After analyzing the nature of the curves, the envelope shown in Fig. 2 can be reasonably broken down into a triangular flat bounded by two elliptical sections. Next step is to reduce the profiles to accurate curves which can be described in terms of tangent radii. Referring to Fig. 2 again, it is again reasonable to assume that the inner and outer curved portions of the elliptical envelope can be developed using two radii for each portion. Based on this premise, the elliptical upper section of the "shovel" must then have one center on the center line of the aircraft and the other at some point horizontally opposite the maximum one-half

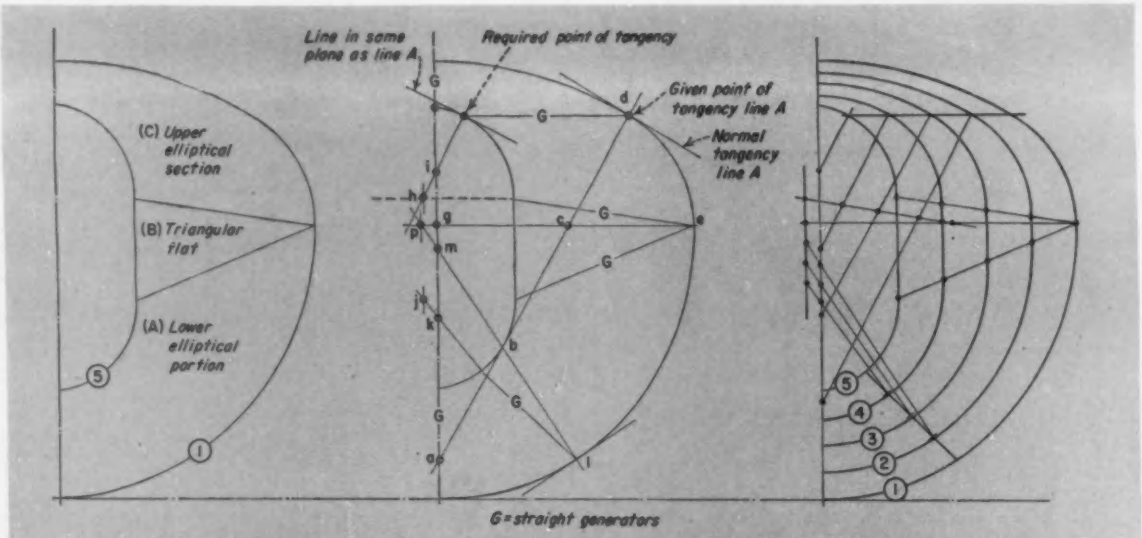



Fig. 2—Roughly drawn profile of an aircraft fuselage section from stations 1 to 5. Envelope is divided by eye into three sections as shown.




Fig. 3—Profile accurately drawn by single curvature technique using tangent radii method. Each curved section is composed of two arcs.




Fig. 4—Development of intermediate station profiles. As with inner and outer curved sections, each curved portion is drawn from two different radii.

breadth point. The latter point can be determined since this radius and all others of its group have to be tangent to the vertical face of the triangular flat at its upper edge.

*Develop Generating Lines.* By projecting a line joining the two centers, the tangent point of the two radii is established. The single-curvature surface between the two dissimilar sections is then developed by setting up the straight generating lines between the superimposed sections. This is accomplished by "rolling" a longitudinal plane about the end profiles and joining the tangent points of each profile to the plane at each of the rotated positions.

The inner and upper portion of the envelope can be developed by drawing two radii to closely approximate the roughly drawn profile using the projection of the line joining their tentative centers. Since the points which define the projection line lie on known vertical and horizontal lines, the point of tangency on the previously drawn generator line is determined. At this stage of the lofting procedure, the envelope can now be broken down into two portions of two oblique cones having radii in the plane of the paper, and one triangular flat with one side in the plane of the paper.

The lower portion of the body, although of different form from the other section, can be analyzed and developed in a similar manner. Restrictions on the positions of the radii centers are the same as before because of the tangential requirements to the triangular flat and the symmetry of the body being developed.

*Completion of Envelope Development.* Preparation for full scale lofting is made by erecting a perpendicular to the base line which gives axes of the aircraft about which to work. The four center line depths of the sections and the three points of the triangle are then accurately laid out. Next step is the drawing of the shoulder radii of the large section. Working from the apex of the triangle, the shoulder radii centers are marked off as they cross the horizontal line through the apex. Then using the center line depths, the two additional radii necessary to complete the section are drawn, each being adjusted for perfect tangency with the centers marked off on the center lines. In a similar manner, four radii complete the inner or obround section.

With the end profiles defined, the resulting equally spaced intermediate sections are drawn. The distance between each pair of centers is divided into four equal parts and the 12 points

---

Any article on a subject covering a new technique or method for accomplishing an old problem always raises questions in a reader's mind. Several of these questions were referred to Mr. Kelley. Their context and Mr. Kelley's answers are listed below.

(Q) Is this single-curvature technique primarily aimed at semi-production applications or can it be adopted for mass-production requirements?

(A) The technique can be used in approximating compound curved surfaces in a pre-production run, later replaced in production by the final design. It is useful in developing the final lines and the detail templates of the members within those lines for full production runs of certain fuselage and engine fairing components. De Havilland's Chipmunk, L-20, Beaver and Otto are such examples.

(Q) Is much of the character of the form lost when going from scale to full size?

(A) With the usual care observed in scale work, no more than a normal amount of variation will result in the refinement of going from scale to full size. Since the form fore to aft is generated by straight lines and the cross-section radii are in the plane of the paper, important dimensions of full scale bodies and their cross-sections can be calculated and proved before full scale drawing.

If the transition is a gradual one, the illusion of continuity is good. But it is

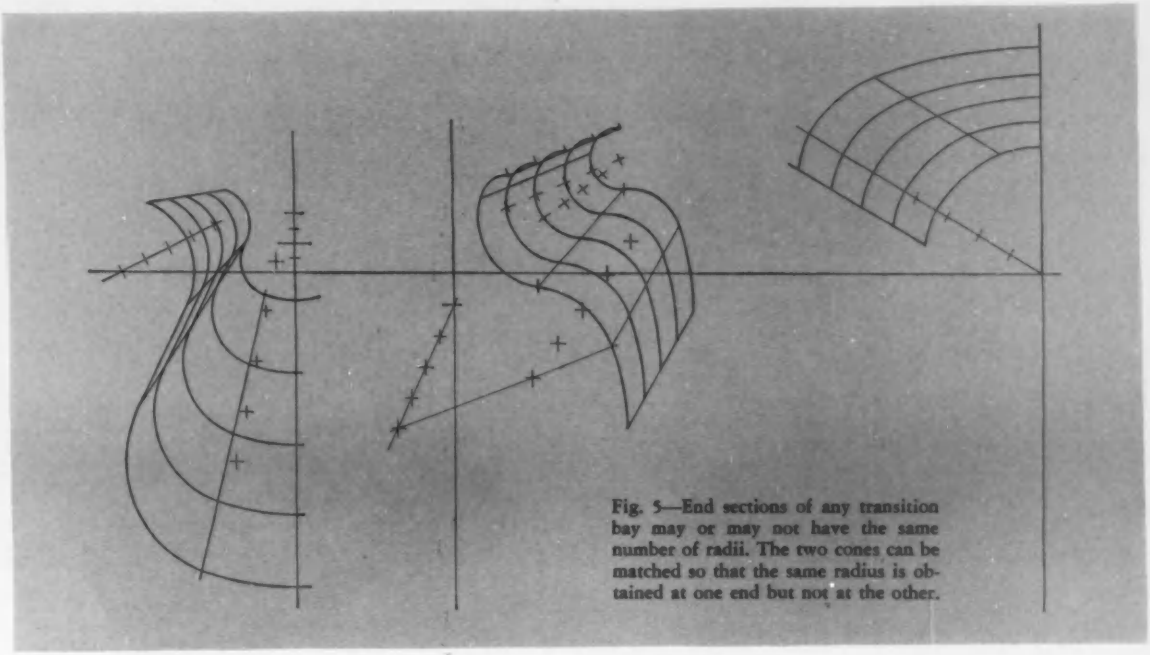


Fig. 5—End sections of any transition bay may or may not have the same number of radii. The two cones can be matched so that the same radius is obtained at one end but not at the other.

marked off. Both sides of the triangle and the top and bottom center skin lines are also divided into four parts with those 12 points spotted. Then by sweeping in arcs matching the previously laid out points, the initial or developing phase of the operation is completed. At this stage of the project, one triangular flat and portions of four oblique cones have been defined, each having their descriptive radii in the plane of the paper.

*Evaluation of Cones in Envelope.* While the envelope shown in illustrations uses only four cones, the choice of the number of cones should be determined by the given form and the fact that each cone must be matched to the adjacent cone on a common straight generating line. To properly create the enveloping sections in terms of radii in the plane of the paper which at the same time define portions of cones matched as stated above, a fair amount of trial and error procedure is required as the number of cones increases. However, the basic technique is still to use the extension of the line joining the centers of the two mating radii as a "wand" for developing the generating line. A good approach is to evaluate the end profiles by eye, selecting tangent points from which to roll target generators and then to develop the cone so that the wand extension settles its series of points in a straight line similar to the target generator. This approach, being graphic, allows a good visualization of the results as balanced against the necessary adjustments to the cones during the project's formative period.

The final phase of the operation is, of course, the preparation of the detailed metal template. Generally the template of an alloy part will show the developed blank size, its reduced profile to suit the offset router, the external formed size or outer mould line of its flanges, and the internal formed size together with all holes.

---

not practical in many applications where the character loss of a finished full size body or portion of it which is composed of several bays fore to aft of single curvature compared to a continuous compound curvature.

(Q) Does this technique reduce or eliminate the use of splines and weights to prove out the design and get various profile views?

(A) The need for splines is materially reduced by using cross-sections as much as possible for compound-curve work since the sections are described by radii rather than coordinates. This procedure eliminates the use of splines and weights in the related frame template drawing operations. It allows longitudinal control to be obtained by two splined lines per segment rather than by a multitude of conventional buttock and waterline profiles. However, for airfoils, involved air-ducts and similar applications, splines are still required.

(Q) How does this technique compare with the speed and accuracy of the second-degree curve technique using logarithmic fairing?

(A) The mathematical lofting technique developed by North American Aviation Corp. in America and Bristol Aircraft in England during the last war has many uses but also some practical limitations. Often, the amount of time, personnel and equipment necessary seem disproportionate to the job's importance. Speed and accuracy, in the layout stage at least, are no greater than usually required.

(Q) Would this technique lend itself to those applications where aerodynamic characteristics are extremely important?

(A) The single-curve technique naturally has its specific uses, being suggested as an uncomplicated and quick means of dealing with aircraft fuselage components composed of single curve envelopes. Numerous sections of modern military aircraft and missiles have the "projectile" look while work-a-day cargo aircraft stress utility forms. This technique is recommended for the latter applications.

Fig. 1—Arma Corporation's induction potentiometer (right). With an OD of only 1¼ in., this is one of the smallest components of its type. Accuracy: 0-1.0 percent. Exploded view (above) emphasizes its simplicity, durability and compactness.

SIDNEY DAVIS
Chief Development Engineer, Components Div., Servomechanisms, Inc.

# Induction Potentiometer

## *As An Angular Position Indicator*

**By producing an electrical signal that is proportional to the angular position of its shaft, the induction potentiometer is becoming an important component in the design of control systems for automatic machines and processes. With an average life of hundreds of million cycles, infinite resolution, high accuracy over a wide temperature range, and inherent durability, it offers advantages over resistance potentiometers for many types of critical control applications.**

PHYSICALLY, the induction potentiometer, or IP, has a motor-like configuration, Fig. 1, with coils so distributed on the rotor and stator as to achieve a prescribed variation in output voltage with angular shaft rotation. It can be considered as a mutual inductance which varies with angular position and has a precisely controlled calibration curve.

In most applications, a single primary winding is excited and a voltage proportional to the shaft setting is developed in a single secondary. Although most units are built for infinite rotation, performance is most accurate when operation is restricted to a band centered about a null position of the output winding.

In simplified form, Fig. 2(B), shows the configuration of the magnetic circuit and windings. A more complete schematic would differ from this diagram only in such non-essential respects as including means for compensating for non-ideal magnetic circuit geometry, and external loading. These can be ignored for the present without affecting the basic principles.

### Performance Characteristics

Except as noted, attention will be directed specifically toward linear potentiometers—those having a straight-line variation of output voltage with shaft position. Fig. 3 shows the correlation between output voltage and winding distribution. The primary

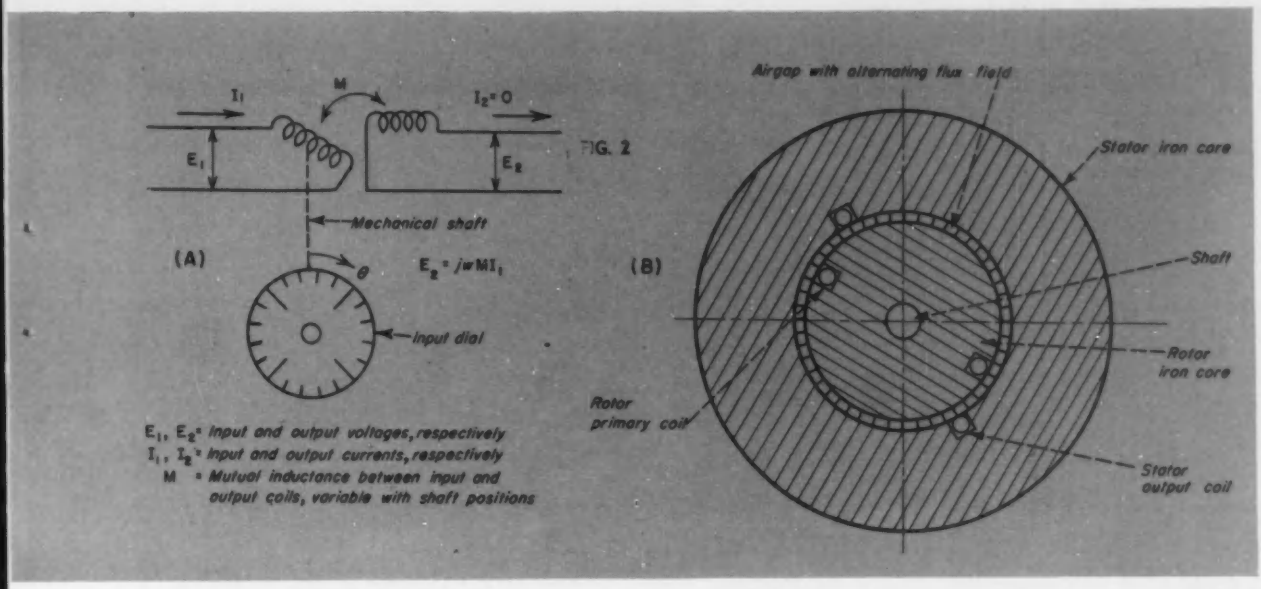



Fig. 2—Schematic (A) shows that the IP is in essence a variable mutual inductance. In the same general category as resolvers and synchros, it is distinguished primarily by the number and arrangement of its windings. (B) is a simplified section of its magnetic circuit. Excited rotor winding sets up an a-c flux field which generates an output voltage in the secondary. Windings are distributed to produce a desired voltage variation with shaft angle.

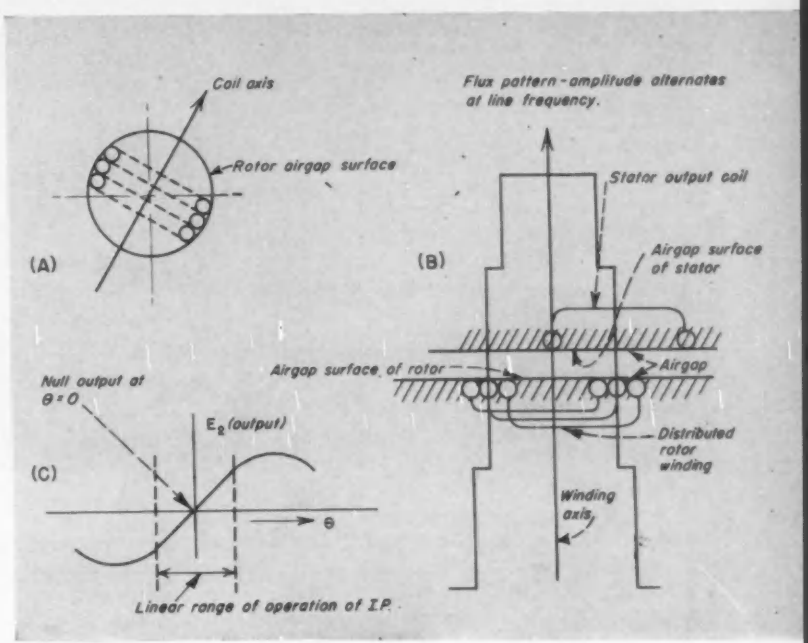



Fig. 3—Typical winding distribution and flux pattern. (A) shows coil distribution on rotor. (B) illustrates the flux in a uniform air gap generated by a winding distribution such as (A). This sketch also shows an output coil for achieving linear performance. (C) shows a typical output voltage curve.

winding distribution establishes the air gap flux pattern, while the secondary distribution determines the variation in output flux linkages (and output voltage) with rotor shaft position in accordance with the fundamental laws of electromagnetic induction. For a given performance, there are usually many satisfactory combinations of primary and secondary windings. Choice is dependent upon such factors as relative accuracy of the individual combination, availability of standard lamination, winding efficiency, comparative sensitivity to non-ideal condition, etc.

Inasmuch as IP performance is governed by the relationship between the air gap flux fields and the output coil, any departure from required configuration of air gap and/or winding introduces errors. Three major error sources are:

1. Non-ideal winding distribution.
2. Non-uniform air gap reluctance, partially a result of slot openings.
3. Machining variations, and non-uniform magnetic permeability. The curves in Fig. 4 show how these errors affect the performance of a potentiometer.

Beside accurate shaping of the output voltage versus shaft angle, proper gain and phase scaling are necessary with the IP. A linear potentiometer, for example, must not only be precisely linear, but the slope and phase shift of the output characteristic must also be controlled closely. Phase shift

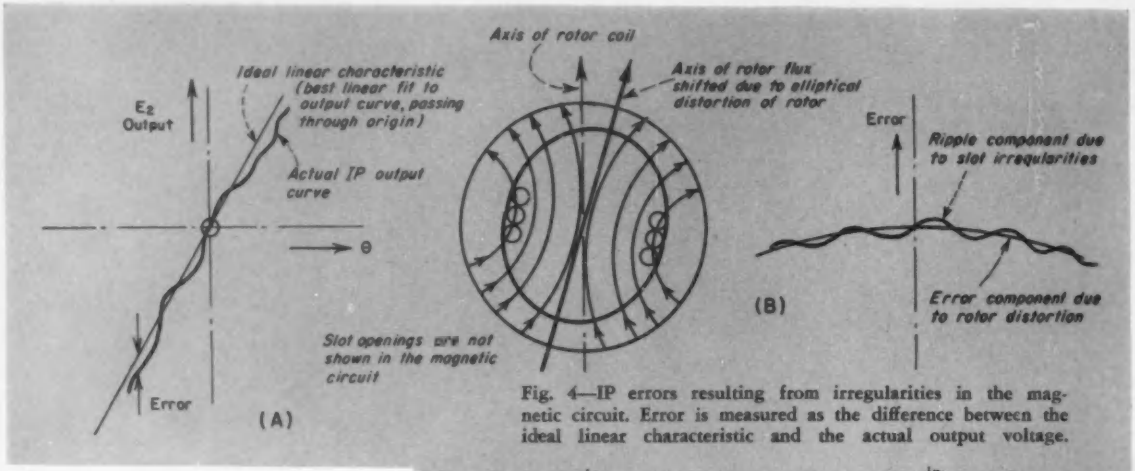
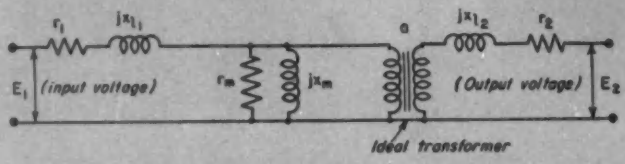

Axis of rotor coil
Axis of rotor flux shifted due to elliptical distortion of rotor
Ideal linear characteristic (best linear fit to output curve, passing through origin)
E2 Output
Actual IP output curve
θ
Error
(A)
Slot openings are not shown in the magnetic circuit
Error
Ripple component due to slot irregularities
(B)
Error component due to rotor distortion

Fig. 4—IP errors resulting from irregularities in the magnetic circuit. Error is measured as the difference between the ideal linear characteristic and the actual output voltage.




a = ratio of primary to secondary coils
$r_1, r_2$ = primary and secondary resistances, respectively
$jx_{l_1}, jx_{l_2}$ = primary and secondary leakage reactances, respectively
$jx_m$ = primary reactance due to airgap flux
$r_m$ = effective resistance corresponding to core loss

The equivalent circuit of the IP defines its characteristics at maximum coupling of primary and secondary windings

Approximate formulas for computation—assuming relatively low leakage impedances, and low core loss

$$E_2 \text{ (open circuit)} = \frac{E_1}{a}\left[\frac{x_m}{x_{l_1}+x_m}\right]$$

$$\text{Phase shift (open circuit)} = \frac{r_1}{x_{l_1}+x_m}$$

$$\text{Output impedance} = (r_2 + jx_{l_2}) + \frac{1}{a^2}(r_1 + jx_{l_1})$$

Fig. 5—Equivalent circuit of the induction potentiometer.

## ELECTRICAL NOMENCLATURE

*Transformation Ratio:* Ratio of secondary voltage to primary voltage when the primary winding is excited and the secondary is at maximum output position.

*Standardization:* Process of adjusting circuit elements to have the transformation ratio and phase angle approach their nominal values.

*Compensation:* Special circuitry added to prevent variations in transformation ratio and phase angle.

*Residual Voltages:* Undesired output voltages present in null position.

*Phase Shift:* Phase angle between secondary voltage and primary voltage.

*Quadrature:* Fundamental frequency residual appearing in IP output, 90 deg out of phase with the useful output.

should be relatively independent of shaft position.

Whereas scaling in a resistive potentiometer is readily accomplished by means of external trimming resistors, in induction potentiometers the inductive input impedance and phase shift lend complications. Furthermore, the IP requires compensation for variations in temperature, frequency, and supply voltage.

Standardization (precise adjustment of transformation ratio and phase angle) is accomplished in either of two ways—by means of networks, which may include temperature and frequency-sensitive elements and sometimes even non-linear elements, or by means of special feedback amplifiers. Amplifiers are often recommended, since they not only provide adjustments for standardization and compensation, but also provide for isolation of components in complex systems. They prevent loading errors and are almost mandatory in the more accurate systems.

The equivalent circuit, Fig. 5, is used for calculating scaling and phase angle, and for predicting the effects of changing temperature, frequency, and applied voltage. Its use is derived from the fact that the shape of the characteristic curve of the IP is relatively independent of operating conditions, and a complete knowledge of scaling and phase is all that is needed to explain changes in performance as operating conditions vary. The equivalent circuit is determined by holding maximum coupling between input and output windings, and treating the component as a conventional transformer. Parameters can then be measured by making open and short circuit tests as described in text books on ac machinery.

Besides showing the form of the equivalent circuit, Fig. 5 defines the parameters, and tabulates formulas for making estimates of complex transformation ratios. Since the leakage impedances of small components such as the induction potentiometer, are relatively high, special methods of measurement are often used to improve their overall accuracy.

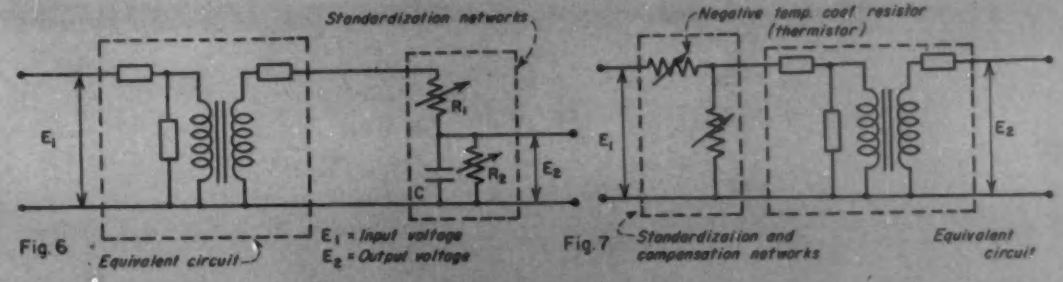



Fig. 6 Fig. 7

Fig. 6—Standardization network adjusts phase shift to zero and accurately sets the transformation ratio. This arrangement is moderately sensitive to fluctuations in carrier frequency, especially in small sizes. Temperature compensation can be achieved by making $R_1$ and $R_2$ temperature sensitive. Fig. 7—This circuit can be used to precisely set phase and transformation ratio, and maintain the values at the desired setting with variable temperature.

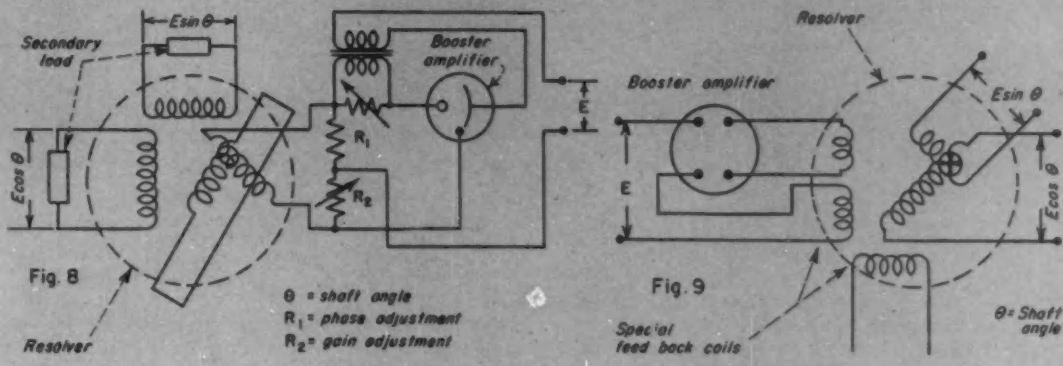



Fig. 8 Fig. 9

Fig. 8—Network type booster compensation circuit shown as used with an electrical resolver can also be applied to induction potentiometers. Fig. 9—Like Fig. 8, this is an electrical resolver circuit utilizing a booster amplifier which can be adapted to the induction potentiometer. This circuit uses special feedback coils to keep the coefficient of coupling to a value of approximately unity. These two circuits are the ones used in most applications.

## Standardization and Compensation

The equivalent circuit representation immediately suggests an approach to standardization and compensation. Elements inserted in either primary or secondary circuits may establish an exact scale factor and phase shift. Suitable temperature or frequency-sensitive components can be included to compensate for variations in those quantities. Thus, the designer need compute only approximate parameters, and establish the general nature of the compensation, since final adjustment is always made by test. Further, inasmuch as output voltage varies in a fixed manner with shaft position, test adjustment can be made at any shaft angle to standard phase and gain corresponding to that angle. The angle of maximum accurate output is frequently used, i.e., the maximum rated angle. To compensate for dissymmetry in the output for positive and negative angles, the average of the output voltages at the extreme positive and negative positions is often standardized. Figs. 6 and 7 show typical standardization and compensation circuits. The arrangement of Fig. 7 achieves zero phase shift which is, by far, the most convenient value for general purposes but is relatively sensitive to carrier frequency shift.

For maximum flexibility and accuracy, booster units are used with induction potentiometers. A booster amplifier may readily standardize, isolate, and compensate, and is well adapted for systems involving chains of components. The techniques of booster operation are similar to those used with electrical resolvers. Figs. 8 and 9 show the two most commonly used circuits, and indicate how they work. The booster and IP are adjusted as a unit, with closely held overall characteristics. Gain and phase shift are adjusted by means of feedback resistors, the values of which are set to compensate for production variations in the units. The resistors are placed inside the IP rather than in the booster so that a booster can be replaced without circuit trimming. This

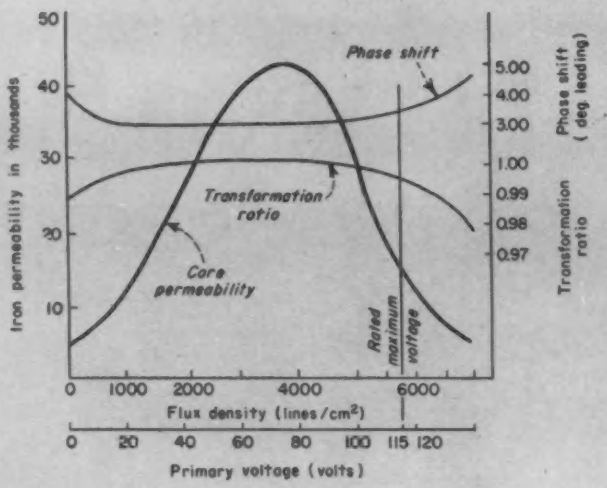
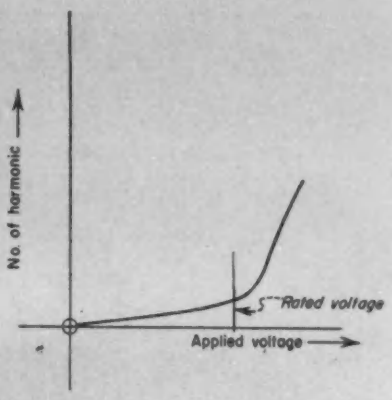



Fig. 10—Typical variations of transformation ratio and phase angle with core permeability and supply voltage. Performance characteristics can be predicted from a knowledge of the core permeability data and the equivalent circuit.

Fig. 11—Harmonics generated by iron nonlinearity dictate the design value of core flux density. These internally generated harmonics must be distinguished from those directly transmitted to the output by a distorted primary excitation. They may be readily found when IP is in a null position.




requires high performance boosters, stabilized by negative feedback, but is of major importance in simplifying maintenance.

While necessary for maximum accuracy, booster systems are complex and costly. A considerable amount of cabling is required in installations between power supply, boosters, and IP's. High quality boosters have many tubes, and external cooling is needed. Reliability suffers. Consequently, for medium accuracies (0.25 to 0.50 percent) designers often use a hybrid approach. IP's, standarized and compensated by means of temperature and frequency sensitive networks, can be used with simple cathode followers for isolation. Sometimes, isolation amplifiers are omitted altogether, or used only occasionally, and rescaling is done by networks to correct for loading. In designing these circuit variations, the equivalent circuit plays a dominant role.

It is common practice for users who do not require highest accuracy, to purchase the basic IP, and to design their own electronic and other components to meet their system requirements. This allows for maximum flexibility. Even for the most stringent requirements, a manufacturer may prefer his own components for greater uniformity, or specialized application.

## Core Effects

Since the IP operates at variable voltage level, the magnetic core flux density varies, resulting in changing permeability. Fig. 10 shows a typical range of variation from low initial mu to maximum, followed by saturation. Units are rarely operated at high core densities because of the need to minimize residual harmonic voltages. Rather than heating, these harmonics, limit the maximum allowable voltage. The equivalent circuit reveals the effect of permeability variations: Shunting inductance $Xm$ varies with input voltage, thereby changing gain and phase shift. Leakage inductance, which results from fluxes lying mainly in air paths, varies negligibly with changes in voltage.

To minimize nonlinearity in $Xm$, high permeability, corrosion-resistant nickel steels are used for core material. Even then, it is easy to have 5-10 per cent of the magnetic circuit reluctance in the iron at low voltage. The error from this nonlinear effect is greatest for very small units, but, by good design, can be kept to 0.1 percent. Sometimes a balancing nonlinear choke can be inserted in series with the primary.

Booster-compensated units are completely insensitive to nonlinearity, since the air gap density is always directly proportional to the applied voltage.

## Residual Voltages

In addition to the desired output, IP's develop a so-called residual output voltage, as a result of electrical and mechanical dissymmetries in their construction. Residual voltages are most conveniently observed at null, where the normal output is zero. They consist of harmonics generated by the nonlinear iron. (Fig. 11 shows variation with voltage level), and quadrature resulting from residual short circuits, such as develop from smearing of the laminated core steel during grinding of the airgap surfaces. Quadrature is especially difficult to cope with, since it is not readily filtered; Fig. 12(A) shows a circuit for reducing this effect by external trimming.

Residual voltage can be measured by the equivalent minutes of angular displacement from null required to generate an equal rms voltage. An alternate measure is the ratio of rms residual to the maximum useful IP output. This voltage is especially harmful where it tends to saturate high-gain amplifiers and overheat motors. Harmonic filters must be used with caution, since they tend to exert an unstabilizing influence on a servo.

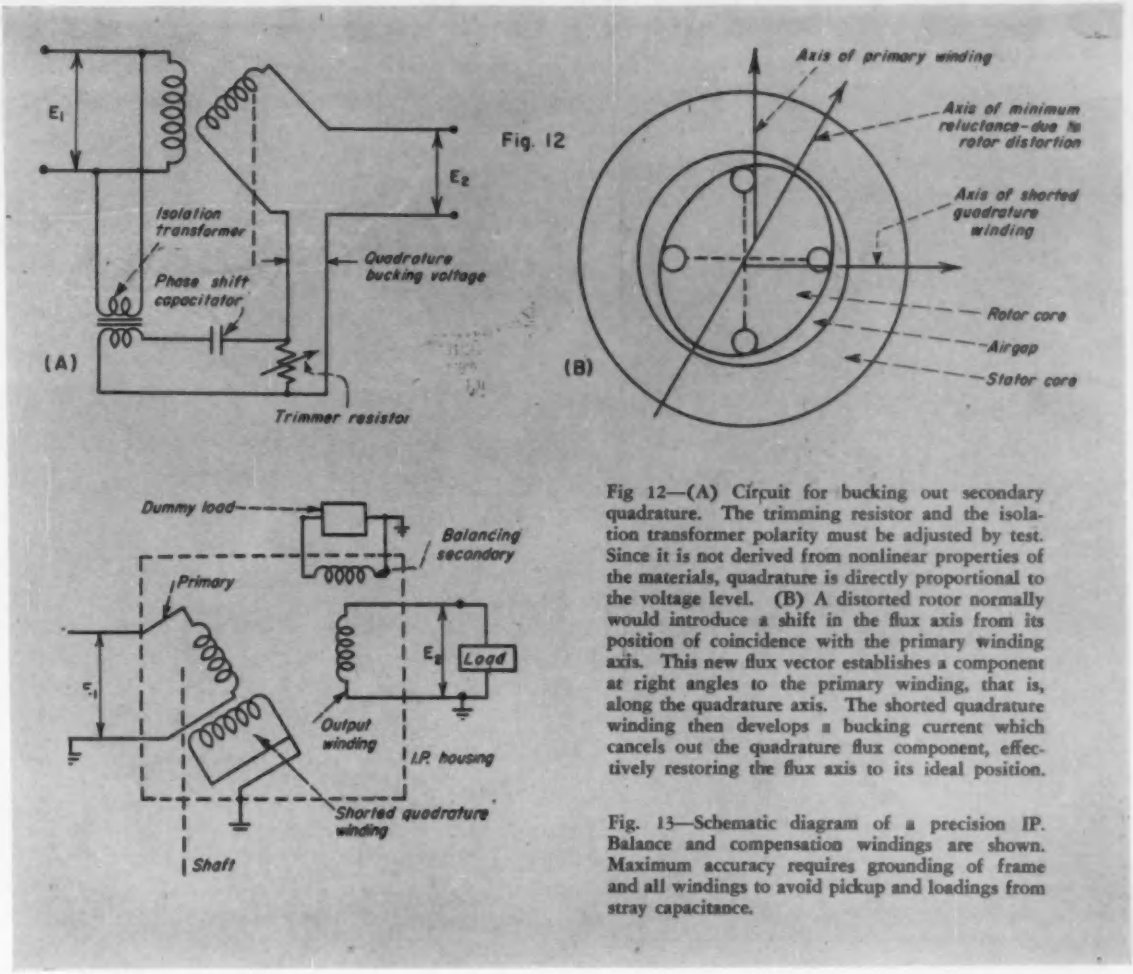



**Fig 12—(A) Circuit for bucking out secondary quadrature. The trimming resistor and the isolation transformer polarity must be adjusted by test. Since it is not derived from nonlinear properties of the materials, quadrature is directly proportional to the voltage level. (B) A distorted rotor normally would introduce a shift in the flux axis from its position of coincidence with the primary winding axis. This new flux vector establishes a component at right angles to the primary winding, that is, along the quadrature axis. The shorted quadrature winding then develops a bucking current which cancels out the quadrature flux component, effectively restoring the flux axis to its ideal position.**

**Fig. 13—Schematic diagram of a precision IP. Balance and compensation windings are shown. Maximum accuracy requires grounding of frame and all windings to avoid pickup and loadings from stray capacitance.**

## Design and Application

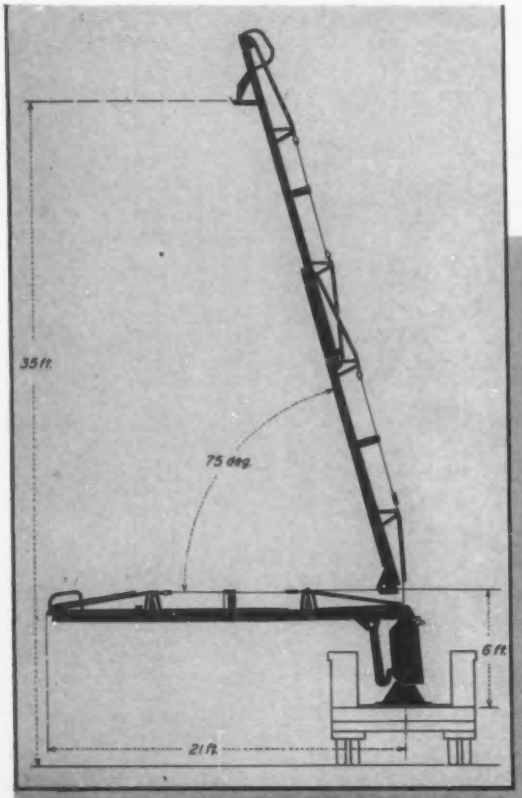
Up to this point, the IP has been described in terms of a single input coil, and a single open-circuited output coil. In practice, additional coils are required to get optimum performance. A permanently short-circuited quadrature winding, at right angles to the primary, compensates for most of the error resulting from non-ideal air-gap geometry. By bucking out stray fluxes at right angles to the excitation axis, this quadrature winding minimizes effects of dissymmetries (Fig. 12(B)), reducing the air gap uniformity tolerances required for a given accuracy by a factor of 5 to 10.

The shorted quadrature winding minimizes the variation in output impedance with angular rotation. In the design of Fig. 3, the use of a quadrature winding reduces the ratio of maximum to minimum output impedance from about 10 to 1, to about 3 to 2. It is this variation in output impedance which destroys accuracy in loaded potentiometers, both of the resistance and induction types. Thus, reduction in the range of variation is of considerable importance. Notwithstanding the use of the quadrature winding, the IP is not to be heavily loaded, and is most accurate when terminated as specified by the manufacturer. Non-standard loading not only changes scaling, which can be corrected, but also distorts the performance curve.

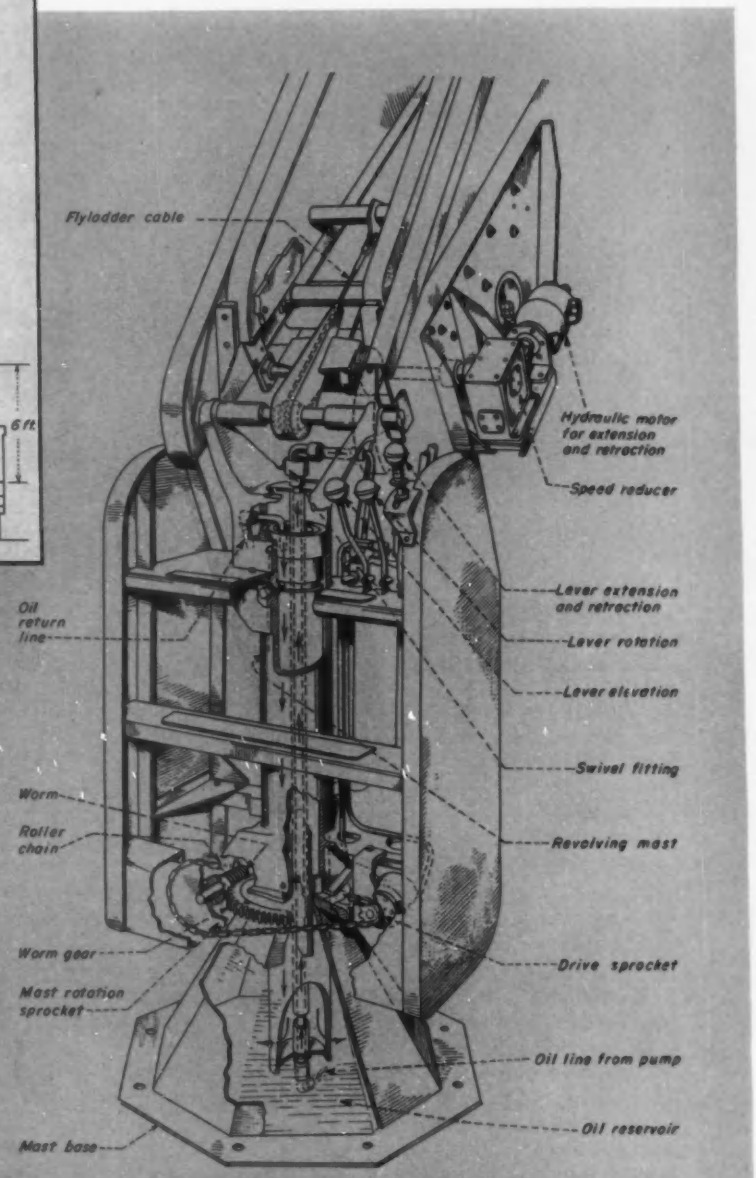
An additional dummy secondary, terminated in the standard load, is also provided in most IP's, to maintain constant primary impedance and input current with shaft rotation. Balanced secondaries increase accuracy; Fig. 13 is complete schematic.

In the application of precision potentiometers, mechanical mounting and driving members must have a precision commensurate with the required electrical accuracy. The limited angular range emphasizes the tolerances to be met in the drive gearing, but the correspondingly low speed of the IP shaft means long life, and little generation of radio noise. The continuous rotation possible with the induction potentiometer eliminates the need for limit stops, a convenience in instrument design. For applications requiring only limited rotation, the IP may be simplified mechanically, and appreciably shortened, by using "pigtails" and limit stops, in lieu of slip rings. When used as pick off units (as with gyroscopes), jewel bearings may be used, or better yet, the IP rotor can be attached to the moving member, the stator mounted on the reference frame.

# Hydraulics Go




REAR VIEW of aerial ladder mounted on a standard light service truck body. Capable of being rotated through 360 deg and elevated to any position within a 75 deg working range, ladder can be extended to approximately 35 ft from ground to platform.




CUTAWAY SKETCH of pedestal which houses complete hydraulic system. Hydraulic motors power the worm wheel and gear arrangement for mast rotation and the winch which extends and retracts the fly section of the ladder. Elevation of the ladder is obtained by a single hydraulic cylinder, not shown in this view.

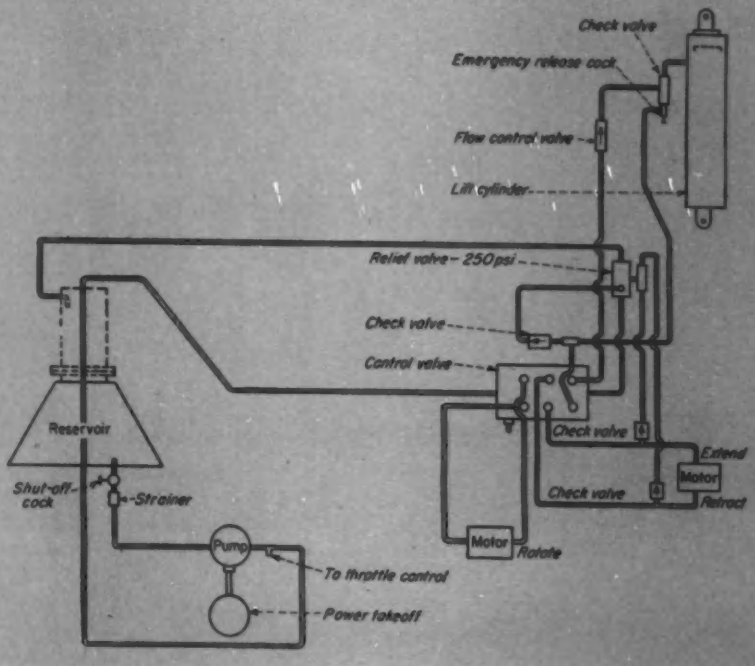
# Sky High in Aerial Scaffolds

Another field in which hydraulics is making a significant inroad is the aerial equipment market where the work to be done often requires precise spotting of the working platform with a minimum amount of manual effort. Heretofore, mechanical equipment filled the bill. But design limitations place a practical limit beyond which construction and operating costs can not be reconciled with additional features obtained.

The transition to full-hydraulic control points up a big initial advantage—that of being easier to work with in the design stage since considerations hinge on power, not on mechanical linkages and spring-type counterbalancing. From the operating viewpoint, hydraulic control earmarks a faster operating cycle, minimum of maneuvering effort, smooth power flow, pin-point spotting accuracy and versatility for packaged installations on different types of mobile equipment.

In addition, designing with hydraulics—though often initially more expensive than mechanical counterparts—removes many of the limitations imposed by pure mechanical design. Such factors as manual dexterity, manual effort, equipment weight, counterbalancing and braking are inherent advantages embraced by hydraulic design.

Illustrated here and on the following pages are two types of aerial equipment. One is designed by J. H. Holan Corp., Cleveland, Ohio; the other, by Tey Manufacturing Co., Milford, Conn.

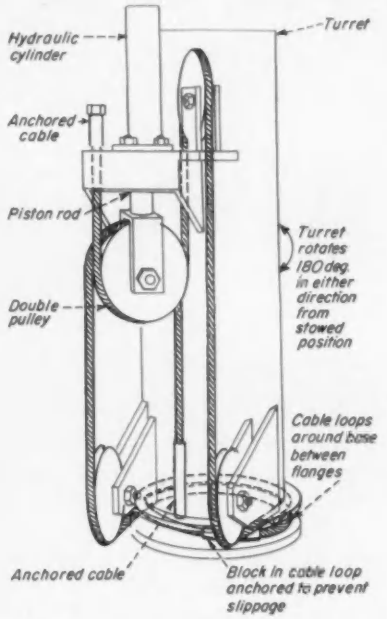



AERIAL LADDER schematic hydraulic circuit designed by Hydreco Division of New York Air Brake Co. A multiple-plunger valve controls all operations. Relief valves prevent overstressing of ladder rung locks and end stops. Use of large lift cylinder permits system to operate at low 225 psi working pressure.

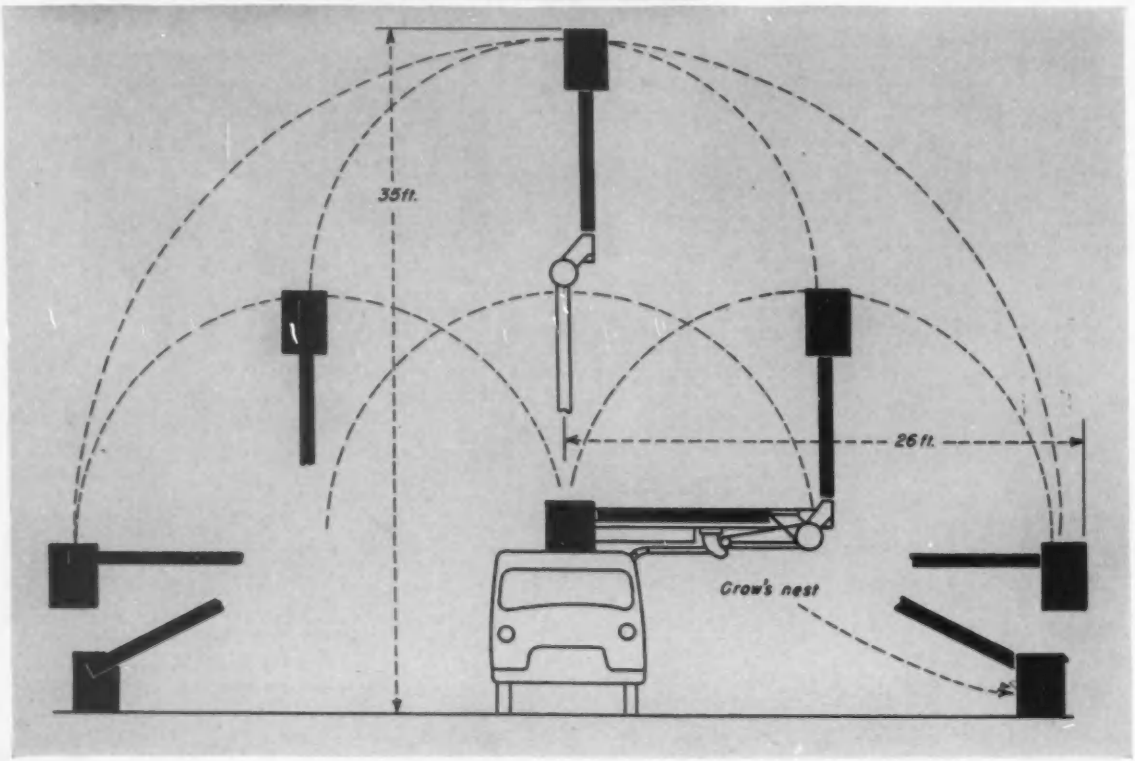
(continued on next page)

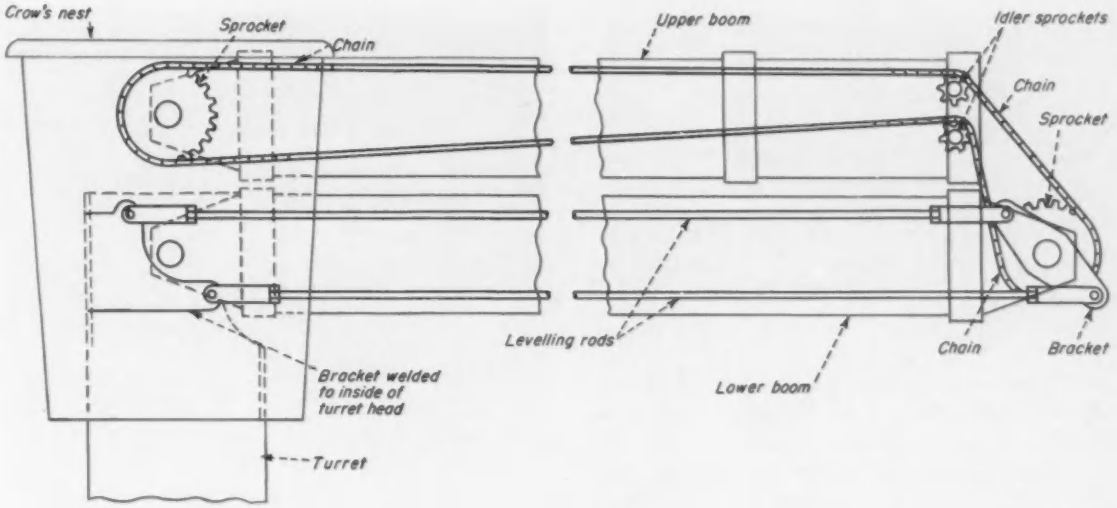
# Aerial Scaffold (continued)

SIDE VIEW of Hydro-Sky Worker mounted on a Schramm Tractor unit. The device can be rotated a full 360 deg and can reach any point in the upper half of a hypothetical sphere having a radius of 26 ft from the boom's mooring. Top working height for this installation is 35 ft from ground, a factor dependent on the type of chassis on which mounted.



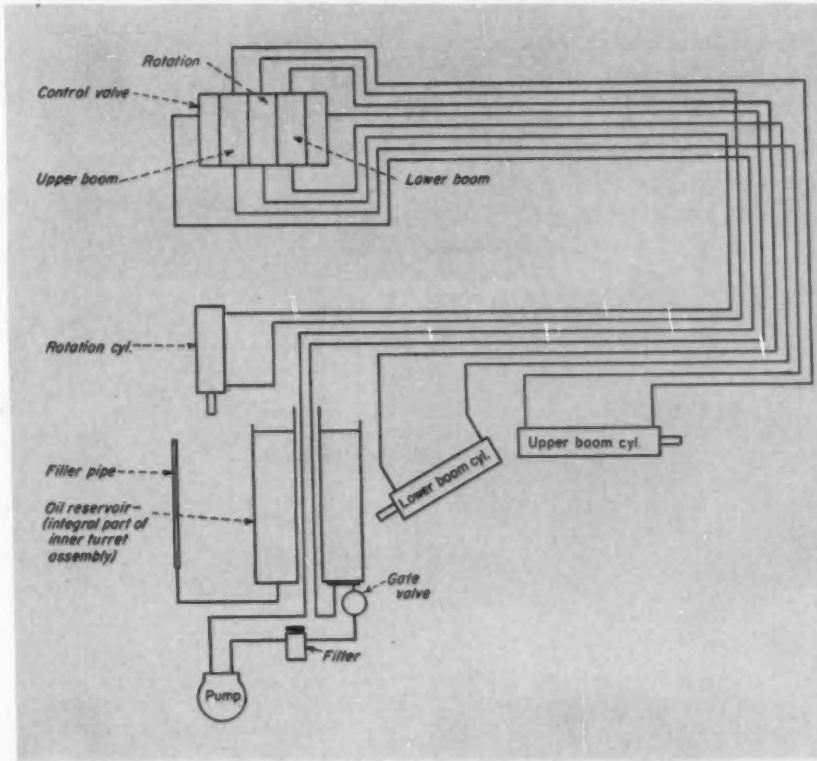

TURRET ROTATION is obtained by the vertical displacement of the cylinder piston rod. Because of the way the cable encircles the turret base, rod movement is directly translated into lateral rotation of the assembly.






TO KEEP THE CROW'S NEST parallel to the ground at all times, a leveling mechanism based on the parallelogram principle is arranged within the upper and lower booms. Consisting of a chain and rod assembly, the mechanism has upper and lower leveling rods anchored to a bracket at the head of the turret and extending through the lower boom to a bracket fixed to the outer hinge pin. With the rods fixed at a 45 deg angle to the hinge points of the lower boom, elevation of the boom causes the parallelogram to change shape. This alters the leveling mechanism of the upper boom, consisting of a heavy chain wrapped around sprocket gears at the outer ends of the two booms, to keep the crow's nest level.

IN CONSTRUCTION, both the inner and outer booms are made from seamless drawn aluminum alloy tubing. The chain drive for the outer boom is a roller chain connected by a whiffletree to a hydraulic cylinder mounted on the inner boom. The inner boom is mounted on a head pin at the top of the turret structure and is driven in elevation by another hydraulic cylinder, not shown in this view.




HYDRAULIC system of Sky Worker operates at 1500 psi with the turret functioning as the oil reservoir. Rotation, raising and lowering of the booms is obtained by actuating hydraulic cylinders from a 3-bank self-centering valve. Cylinder restrictors are used to permit a slow rate of descent should line failure occur. In some installations, both turret and crow's nest are equipped with boom controls to allow remote control of equipment.

# New Small Car—

## Latest Automotive Venture

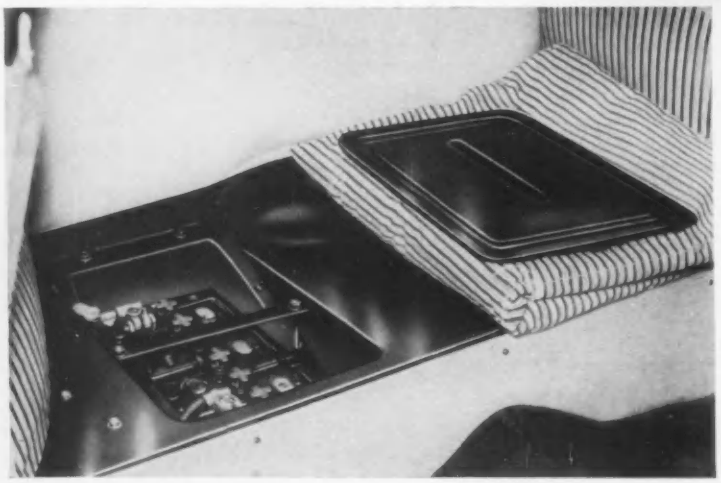
With the recent introduction of their new Metropolitan models, Nash Motors Division of American Motors Corp. culminated an 11 year old belief that the continental concept of a small car could be combined with American styling tastes and performance standards. What Nash came up with were 2-3 passenger convertible and hardtop models having only a 85 in. wheelbase, weighing approximately 1800 lbs—but maintaining a big car's head and leg room.

For the first few production runs, until the buying pulse of the American public can be taken, the Metropolitan will be imported from England. Two reasons prompted this decision: 1) To take advantage of small car production "know-how", and 2) To minimize the initial tooling investment.

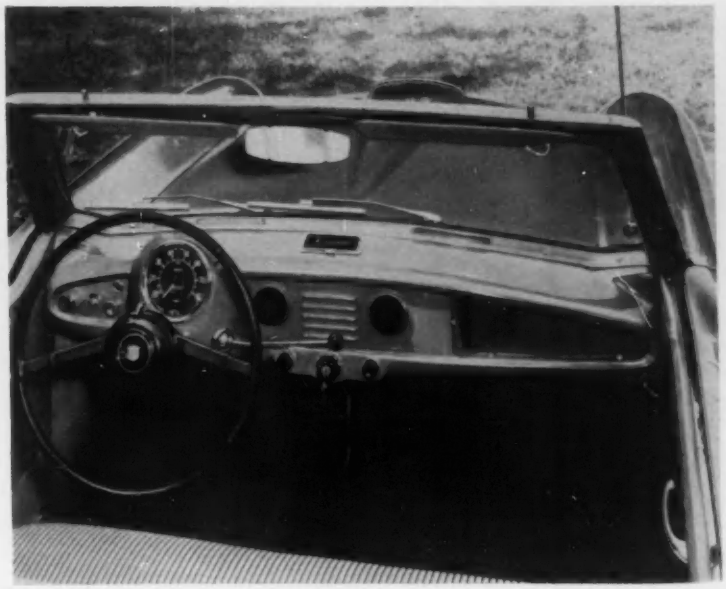
Emphasis is placed throughout the design on engineering and product quality. For the power plant, the performance-proven Austin 32 hp, 4-cylinder overhead valve engine was selected. For the transmission, Austin's synchromesh drive is used but modified for only 3 forward speeds. Brakes are another big point. The Girling floating shoe type were adopted, featuring a bonded lining with twin hydraulic cylinders at the front and a single cylinder at the rear wheel brakes.

NOT A SCALED-DOWN "big car," the Metropolitan is engineered throughout as a small car to meet American performance standards. Overall dimensions are length 149½ in., width 61½ in., height 54½ in.

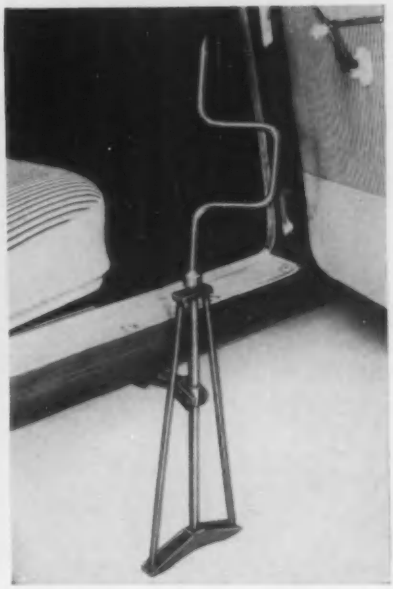
CONTINENTAL LOOK is kept with rear mounted spare encased in an off-white Vinyl cover. Tail lights give appearance of being mounted in conventional chromium bezels. But closer scrutiny points out frames as clear plastic with chromium plating on interior surfaces.



ENGINE'S FASTER cranking and running speed plus 7.2:1 compression ratio pointed way to 12 v electrical system. Battery is located under rear seat, the reason for which is lack of space under hood. Luggage space, approximately 6 cu ft., is reached by folding down rear seat back cushion.

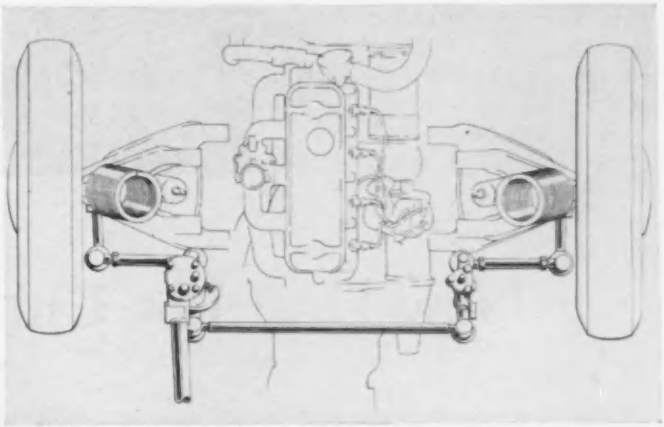


DASHBOARD VIEW shows some similarity to Rambler line. Interesting items are flat windshield, electric windshield wipers, directional signal control on steering wheel and standard equipment cigarette lighter. Radio and air-circulation system are optional. Overall steering ratio is 21:1, with $2\frac{2}{3}$ steering wheel turns being needed to go from left to right wheel lock.



TIRE-CHANGING is made easy. Jack is simply inserted in a bracket located along frame on each side. As side is raised, both wheels are not simultaneously lifted. Front wheel lifts first.

PRIMARY CHANGE to Austin engine is in use of 4 piston rings instead of 3 for better control of oil consumption. Note fuse box positioned at upper right for easy accessibility. Not shown is hand priming lever on fuel pump, a European small car feature adopted for U. S. market.



STEERING LINKAGE has been redesigned for easier servicing. Linkage has been taken from under the engine and re-routed over the engine bell housing. This re-arrangement also insures protection against possible road damage to any part of steering system, and allows easy toe-in adjustments.

*Editor's Note: According to a recent report by Business Week, the Metropolitan has caught the fancy of the American public. Introduced at a time when the automobile industry is girding itself for an all-out competitive battle, the new car sold out of many Nash showrooms in a few days. Sales reports soon prompted Nash officials to up production quotas by 60 percent to allay fears of dealers that deliveries would fall way behind sales.*

(A) THE AUTOMATIC drill head is shown in a production set-up where it is being used to drill small lock-screw holes in die-cast parts. In this operation, the operator employs a foot control, leaving his hands free to feed and remove the parts.

(B) COMPACTNESS of design is illustrated in this cross-section view. Operation of the drill is based on air being discharged to the compression chamber by a small rotary air compressor. The piston assembly is then forced down by the compressed air feeding the drill into the work. When the drill stroke is completed, built-in controls are designed to open the motor circuit and exhaust valve permitting the return spring to re-position the piston assembly for the next operation.

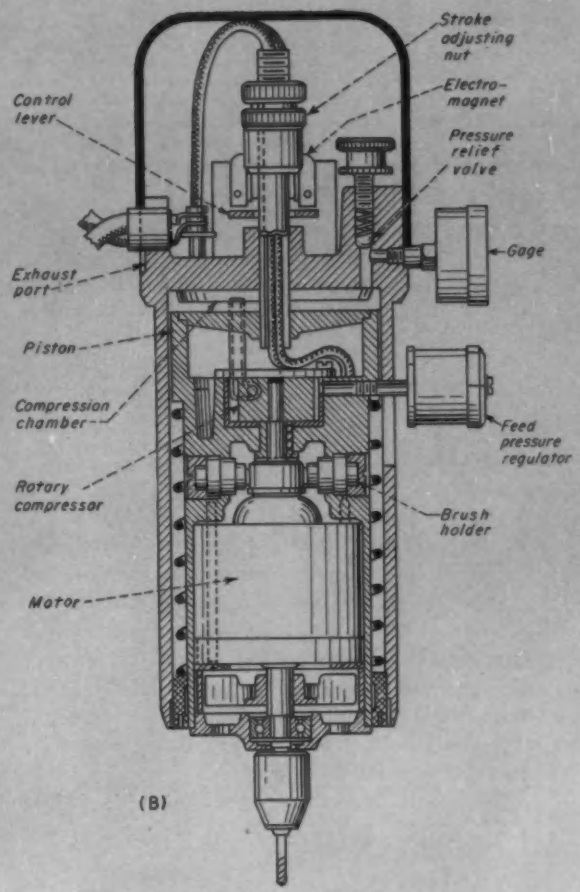
# New Drill Has Unique Self-Adjusting

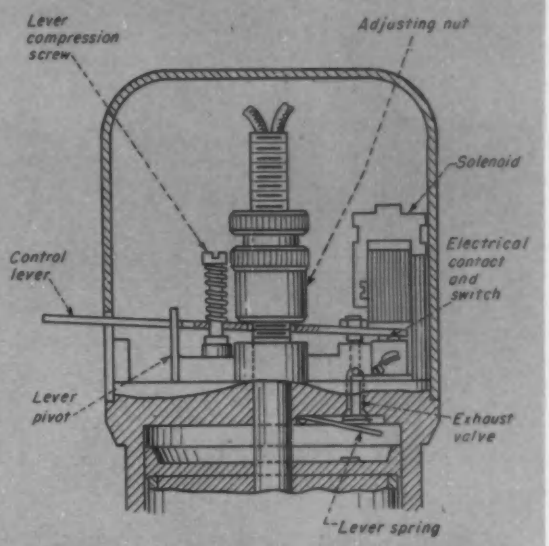
By using the relationship between drilling resistance and tool spindle motor torque to automatically determine the proper drill feed and speed, the Dumore Co., Racine, Wisc. has developed a compact unit having unusual operating flexibility without the danger of costly drill breakage.

Basic element in the design is a self-contained power assembly which consists of a small rotary vane type air compressor mounted on one end of the motor shaft, the drill chuck being at the other. Fitting inside and attached to a single action piston—the drill body forms the cylinder—the entire unit moves when the feed stroke is engaged. Thus, by simply regulating the volume of air to the compressor, the drill's feed and thrust is closely controlled and automatically adjusted.

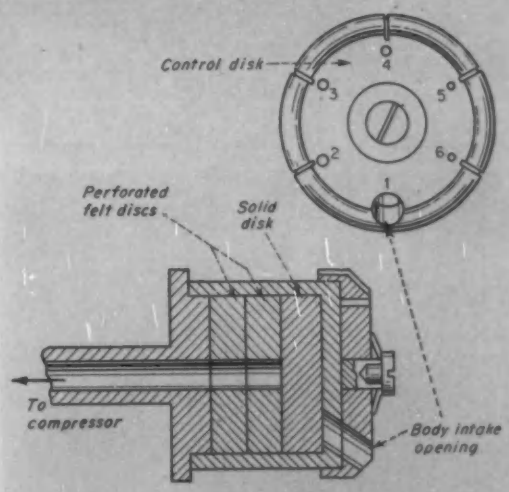
The self-adjusting feature of the drill feed is obtained by variations in motor speed corresponding to drill resistance encountered. Any decrease in speed immediately results in a reduced volume of compressed air to act on the piston. This, in turn, reduces the piston thrust and rate of drill advancement towards the work. Conversely, when drill resistance decreases, motor speed increases with the resultant increase in volume of compressed air forcing the drill at a faster rate into the work.

Built-in controls are another important design feature. The air intake regulator not only regulates the volume of air to the compressor but also serves as an air filter and oil reservoir for the system. Feed stroke is selected




**STROKE CONTROLS** are located in the upper shell of the unit and are actuated by movement of the piston shaft. As compressed air forces the piston down, the stroke adjusting nut on piston shaft bears against the control lever pivotting it to depress the motor switch contact and exhaust valve stem. At full stroke, the lever is pivotted sufficiently to open the motor circuit and the compression chamber exhaust valve.

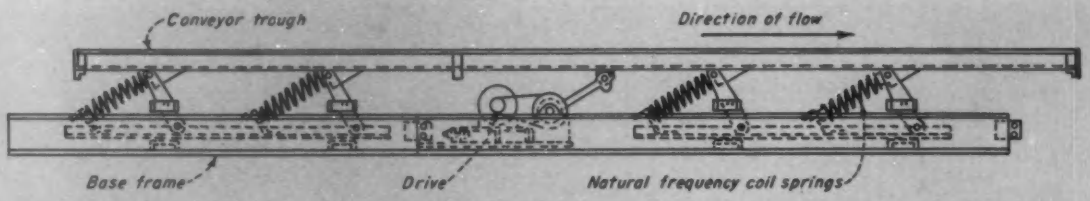



**AIR REGULATOR** is shown in cross-section and as seen by an operator. The solid disk acts as a filter with the others as an oil reservoir for the compressor. The control cover which has different sized holes corresponding to drill sizes commonly used aligns the proper intake hole with an air passage in the regulator body.

# Feature

by positioning adjusting nuts on the piston rod, the position of the nuts determining the point at which the electrical circuit is broken and exhaust valve opened. Other controls are for air pressure and phase relationship between motor cut-out and exhaust valve opening.

***To be marketed in September is the latest addition to Dumore's line of drilling equipment. A self-contained automatic drill unit requiring only a low volume of air supply and an electrical power source, it is designed for use with indexing and sequential type operations. Plug-in type accessories include a hydraulic package to precisely control feeding rates, and an electronic timer to control drill withdrawals for deep hole drilling.***



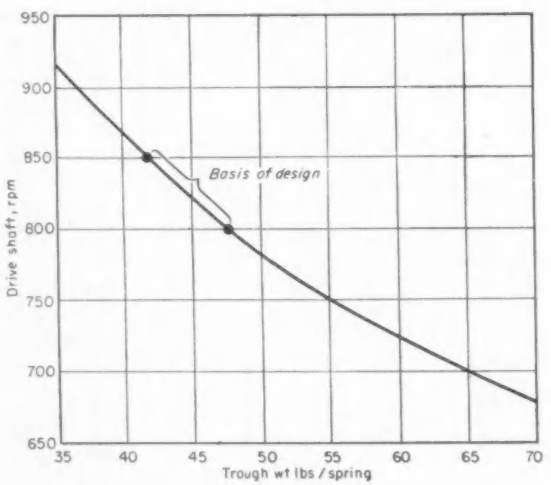

SKETCH illustrates basic construction of a natural frequency conveyor. Power is generally supplied by a standard induction motor, the speed of which is reduced to drive the eccentric at the natural frequency of the springs. Since a minimum of vibration is transmitted to base frame, unit can be mounted or suspended without use of special foundations or bracing, or in temporary locations without anchoring.

# Resonance—A "Natural" Conveyor

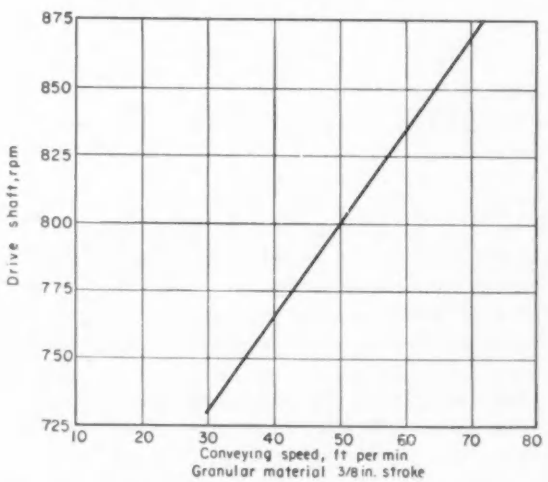
**While considerable progress has been made in the means to reduce or eliminate vibration in power driven equipment, equally important has been the effort in the opposite direction, that of putting resonance to useful work. One example of this is a natural frequency conveyor designed by Stephens-Adamson Mfg. Co., Inc., Aurora, Ill., to convey granular types of material.**

**Main design feature of this relatively new type of equipment is the utilization of the energy absorbed by the conveyor's supporting springs. By designing the springs to alternately operate in compression and tension, and at their natural frequency or resonance, full advantage is taken of the absorbed power which is regenerated by the springs at the end of each stroke to start another. And since the springs are mounted to the conveyor at a predetermined angle, resolution of the vector forces give the material a constant forward flow or travel.**

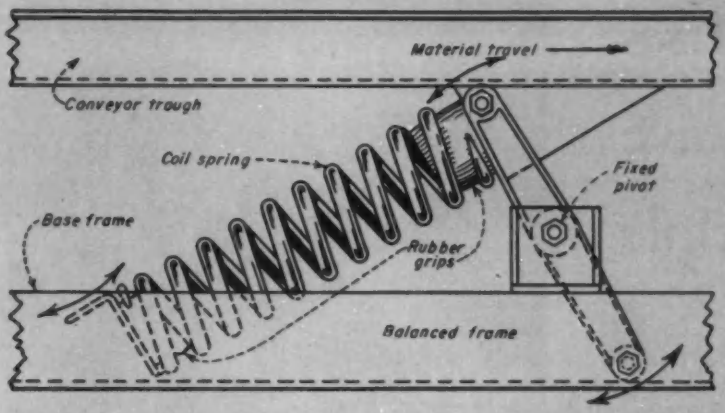
**Several advantages are inherent in this design:**




THIS BALANCED TYPE of vibrating conveyor is designed to operate at a natural spring frequency from 800 to 850 cpm. This range gives a satisfactory conveying speed for most materials and allows about 45 lbs of trough weight per spring.



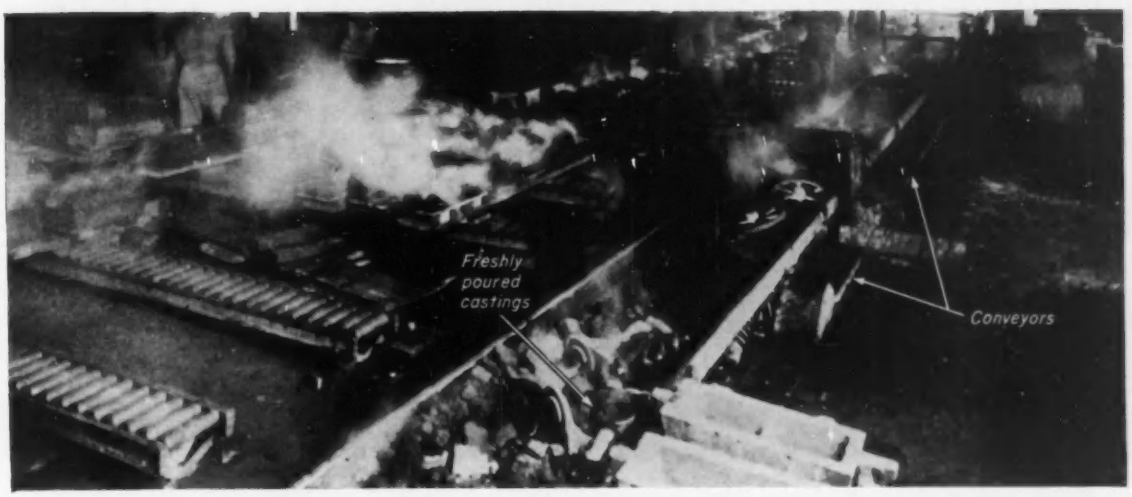

CONVEYING SPEED is indicated on this graph. Factors affecting the optimum speed are shape of granule, weight per cu ft and aeriation tendencies. Capacity can be varied by changing depth of the material on the trough. A typical speed of flow for a balanced type conveyor is 60 fpm.




CLOSE-UP SKETCH of one spring station shows simplicity of assembly. Since both ends of the spring move an equal amount in compression as in tension, the movements of the conveyor trough and balance frame neutralize each other. Low-stress coil springs are fastened at each end by rubber spring grips. Resilient rubber bushings are used for rocker arm pivots to cushion shocks, reduce power required and to reduce the number of necessary lubrication points.

low power requirements, simplicity of construction and a minimum of vibration which is self-balanced within the unit. The only power required from an external source is that of overcoming friction losses in the bushings, internal friction losses in the springs and power required to move the material. Construction simplicity is pointed up by a unit which essentially consists of a carrying trough, counter weight, coil springs supporting the trough and counterweight, rocker arms, eccentric drive and supporting frame. Because of the minimum number of moving parts and the spacing of the springs along the entire length of the trough, energy is added uniformly thereby reducing maximum trough stresses.

While the balanced natural frequency conveyor reduces vibration to a minimum, some applications require that even the small amount of vibration not be transmitted to the supports by the eccentric drive. For these applications, inertia blocks mounted on rubber or springs are used.



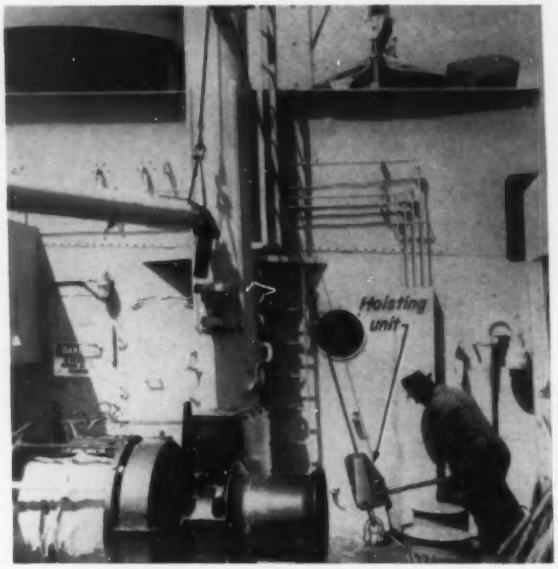

TWO 45 ft long natural frequency conveyors are shown in use in a West Coast foundry, the impact of vibration serving to separate the sand from the castings. Both conveyors are powered by 5 hp drives, sufficient to move castings weighing up to 100 lbs at a speed of 85 fpm. Since conveyors are loaded just following a pour, castings reach trough at red heat. But heat dissipates rapidly and trough never gets uncomfortable to the touch.

# Cable Hoist Uses Old Basket-Weave Principle

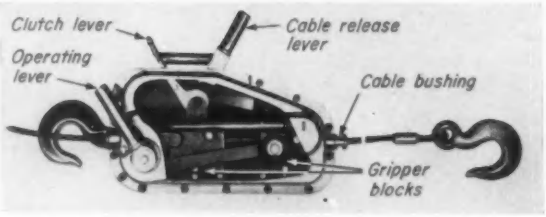
The newest of portable, lightweight, manually-operated hoisting or pulling devices borrows a page from one of history's oldest design principles, that of the ancient Chinese basket-weave. Essentially consisting of a crank and cam mechanism to simultaneously open one set of gripper jaws while closing the other—each set moving in opposite directions—the new machine can pull a full load at speeds up to 10 ft of cable travel per minute or can inch the cable in increments measured in thousandths of an inch. Because of the positive gripping action and the design principle of the harder the pull, the tighter the grip, the load can be securely held in any desired position. Tests showed that a 3,400 lb load applied to the machine for 24 hours caused no measureable cable slippage.

Rated at 3,300 lbs using a single ½ in. dia steel wire rope, the Tirfor Griphoist can be used with multiplying sheaves for loads ranging from 3 to 10 tons. Cable length is unlimited since the operation is based on the cable being pulled through the unit.

The hoist is manufactured by Secalt, Grand Duchy of Luxembourg. American agents are Griphoist, Inc., 544 Market St., San Francisco, Calif., and Princeton Griphoist, Inc., 32 George St., Boston, Mass.




A TYPICAL use of the hoist is in its application on the deck of a "dead" ship. Secured to an eye, the 42 lb device is being operated to raise the boom from its pivot.



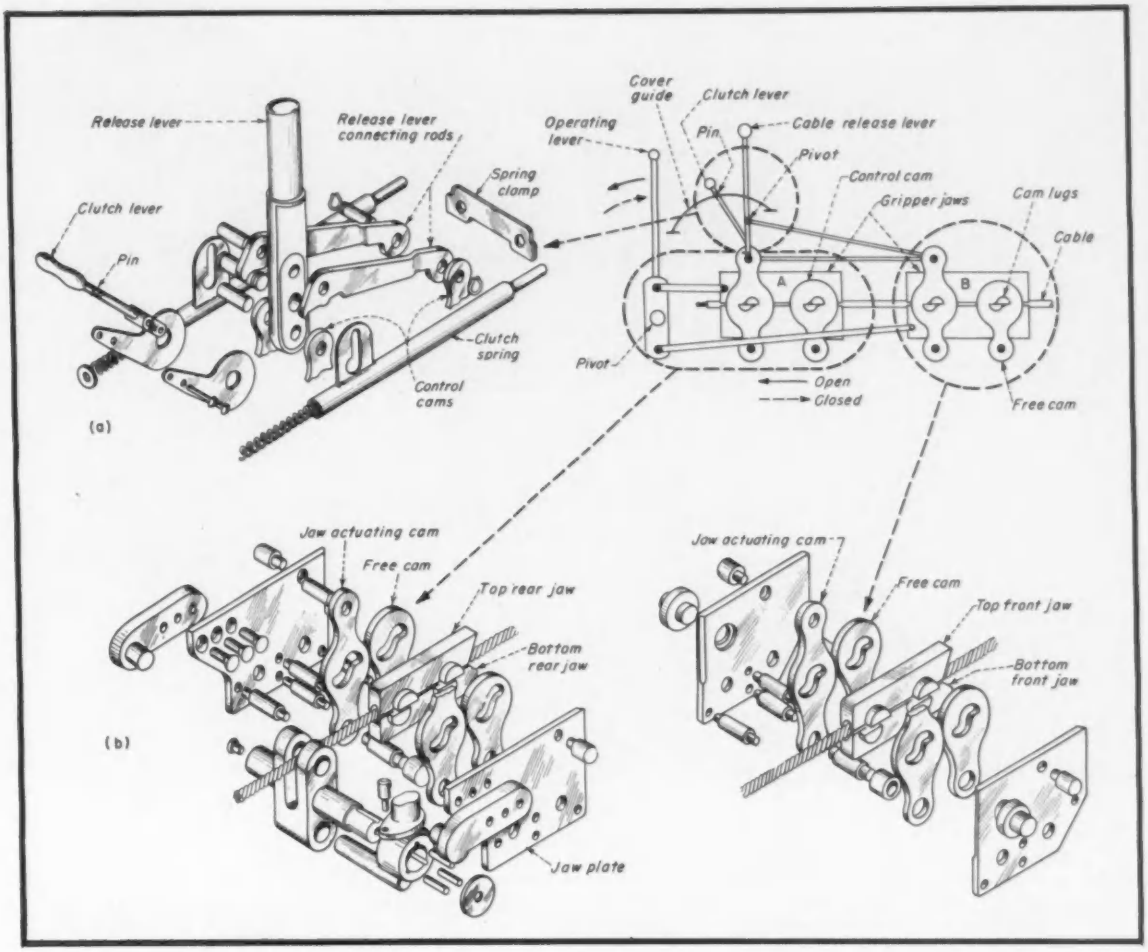

CUTAWAY VIEW of the Griphoist. Machine can be operated in any position with reciprocating motion of operating lever used to draw cable through machine. Release lever is operated in same manner as operating lever and is used to release load. Clutch lever is used to fully release gripper jaws for introduction of cable into bushing and through machine, or for removal of cable when tension is released. This prevents accidentally dropping the load.

## Free Piston Air Compressor Has Promising Future

EMPLOYING the opposed piston principle developed by Professor Junkers, a new design for stationary and portable compressor work is now being extensively tested by Acrow, Ltd., England. Results obtained to date indicate marked advantages over conventional diesel powered units. Numbered among the advantages are low fuel consumption, no vibration—hence reduced installation costs, long service life before overhaul, simplified maintenance procedure and closely regulated operation.

The working cycle of the compressor is essentially that of a diesel engine, the power unit operating as a 2-cycle diesel unit. Quantity of air delivered is controlled by automatically varying the amount of fuel injected, which varies the length of the piston stroke. With the two pistons moving freely between air buffers in the compressor and power cylinders, there is no mechanical limitation on the working stroke.

Principal advantages can be broadly grouped under mechanical and thermodynamic headings. Mechanically, there is no primary couple with the second-




SCHEMATIC OF HOISTING MACHINE and associated exploded views of main elements. *For drawing cable* through machine, operating lever is reciprocated, the length of arc determining the amount of cable travel. For movement of the lever to the left, gripper jaws A are opened and pulled to the left, gripper jaws B tightening on the cable and pulling it to the right. As lever is reversed, jaws B open and are pulled to the left; at the same time, jaws A tighten on the cable pulling it to the right. *To release the load,* the release lever is reciprocated, the action of which reverses the pivots of the actuating cams and thereby feeds the cable in the opposite direction to that obtained when moving the operating lever. *The clutch lever* when moved to the left pivots the two actuating cams to fully open the gripper jaws. This element is used only for initially loading the cable into the machine.

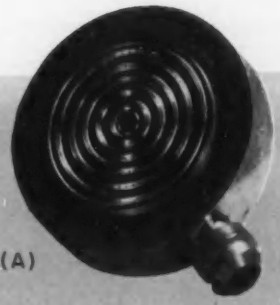
ary out of balance forces considerably less than for a conventional diesel engine plant. Also, the relatively small diameter of the opposed piston units results in a proportionate reduction in internal cylinder pressures. Since there is a minimum number of moving and rotating parts, vibration is practically non-existent. This feature, in turn, points up substantial savings in installation costs and permits greater flexibility in mounting. Where air is required on upper floors of a building, compressors can be installed on those floors saving the cost of piping. If necessary, the units can also be mounted on wall brackets saving floor space.

Another feature obtained by the minimum number of heavy rotating components is a practically instantaneous governor response. This is reflected in a stable engine speed and low fuel consumption. Lubrication is by the total loss principle, metered quantities being introduced to necessary points at regular intervals. In terms of service life, the use of clean oil at all times enables working parts to operate for long periods with the need for overhaul.

Starting of the unit is affected by introduction of high pressure exhaust gas into the second stage cylinders. Since the storage bottle is connected to the combustion chamber, recharging is a simple operation. Also, adoption of this method permits operation in extremely low temperatures.

# DRY HYDROGEN BRAZING

## *For High Strength Alloys*



**Materials such as stainless steels, Nichromes, silicon steels, and stellites now can be fabricated by furnace brazing methods as a result of the development of pure dry hydrogen atmospheres. Thus, products with high strength, corrosion resistance, oxidation resistance and hardness can be produced from these materials on a production rather than manual basis. Some other advantages are:**

**1. No flux is needed; the cost of the flux, time and labor required to apply it are eliminated.**

**2. Charge comes from furnace clean and bright —no additional cleaning is necessary.**

**3. New alloys, and materials like ceramics, that are impossible to braze in ordinary atmospheres can be fabricated.**

**4. No danger of weak joints from trapped flux or corrosion by flux when parts are exposed to the atmosphere.**

**5. Complicated shapes, not possible with other methods, can be produced at reasonable cost.**

FLOYD C. KELLEY
Research Laboratory
General Electric Company

HIGH CHROME and silicon steels have generally been brazed by hand using a flux and gas torch, resulting in slow and costly production. Furnace brazing with a flux in protective atmospheres has also been tried, but it merely reduced the amount of oxidation as compared with the manual methods. It has only been with the development of dry hydrogen atmospheres that both the flux and oxidation problems are completely eliminated.

The parts or assemblies to be brazed are carefully cleaned by chemical methods, grit blasting, machining, grinding or wire brushing and placed in a perforated tray in the charging vestibule of a retort-type furnace. After thoroughly purging this area to prevent contamination of the hydrogen, the tray is moved into the heating chamber where it is left for the desired time. Then, it is moved to the cooling area before being removed from the furnace. For large production quantities, conveyor belt can be installed.

### BRAZING MATERIALS

Dry hydrogen makes it possible to use brazing materials containing large percentages of such elements as chromium, silicon, boron, manganese, and titanium without the use of a flux. The atmosphere cleans and protects the brazing materials from oxidation as well as the materials to be brazed.

Several high manganese-nickel alloys have been used such as 20 Mn-80 Ni; 40 Mn-60 Ni; and 60 Mn-40 Ni. These are desirable because they are not easily attacked by mercury and

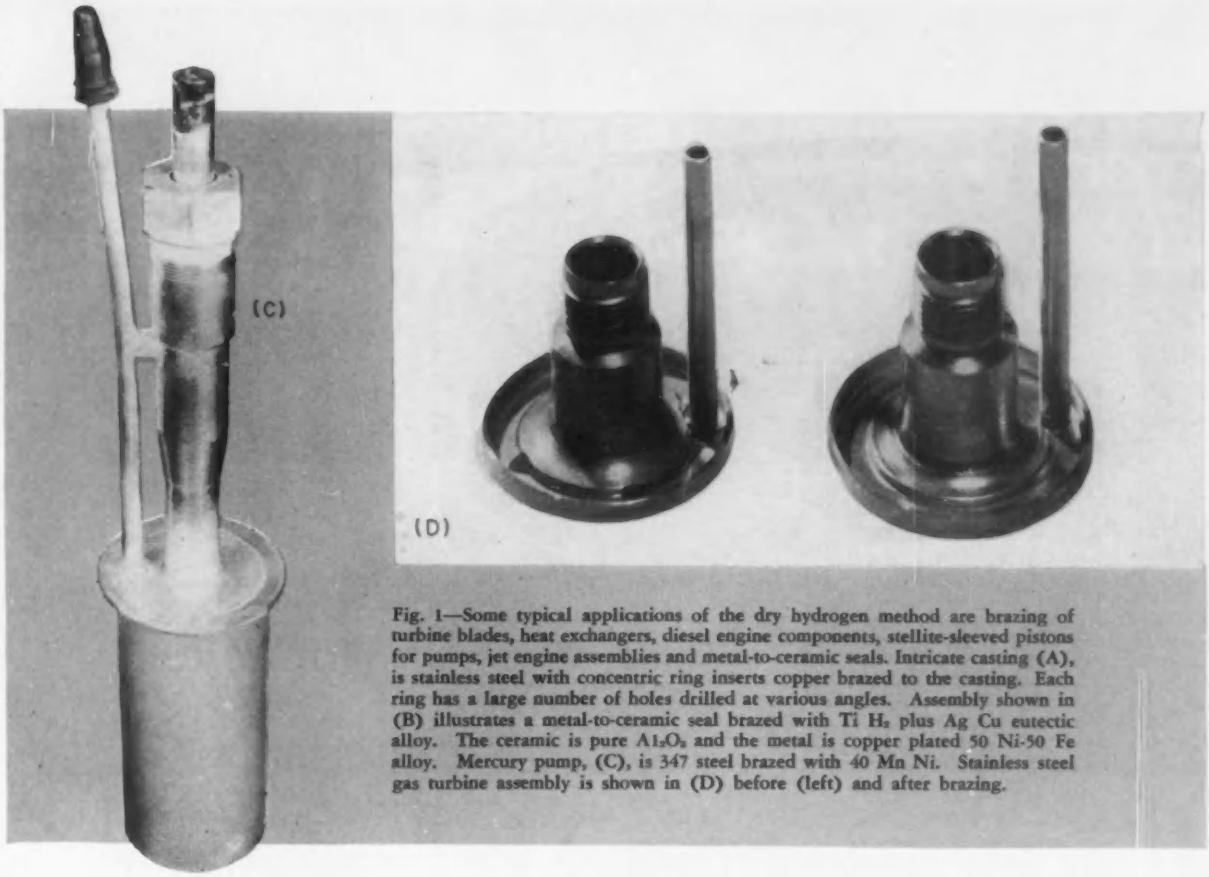



**Fig. 1—Some typical applications of the dry hydrogen method are brazing of turbine blades, heat exchangers, diesel engine components, stellite-sleeved pistons for pumps, jet engine assemblies and metal-to-ceramic seals. Intricate casting (A), is stainless steel with concentric ring inserts copper brazed to the casting. Each ring has a large number of holes drilled at various angles. Assembly shown in (B) illustrates a metal-to-ceramic seal brazed with Ti $H_2$ plus Ag Cu eutectic alloy. The ceramic is pure $Al_2O_3$ and the metal is copper plated 50 Ni-50 Fe alloy. Mercury pump, (C), is 347 steel brazed with 40 Mn Ni. Stainless steel gas turbine assembly is shown in (D) before (left) and after brazing.**

some other metallic elements in the molten state. The amount of the Mn-Ni alloy used in brazing stainless steel such as 347 must be determined carefully because if too much is used, the brazing alloy attacks the stainless producing an excess of liquid phase. The alloying action can take place to such an extent as to produce holes in 20 mil 347 sheet material.

Several hard surfacing alloys with varying compositions have been used to braze stainless steels and produce joints which have high temperature strength. A typical composition is:

| | | | |
|---|---|---|---|
| Ni | 65–75 | Fe | 10 percent max. |
| Cr | 13–20 | Si | |
| B | 2.75–4.75 | C | |

This alloy is produced in powder form for brazing and has a long solidus-liquidus range. If the charge being brazed has a large mass and cannot be heated rapidly through this range, the low melting liquid phase will run into the joint leaving a skeleton of the solid phase behind. With poor heat conducting materials such as the stainless steels, it is desirable to hold the temperature of the furnace at a temperature just below the melting point of the brazing material long enough to allow the charge to come to equilibrium. Then, enough energy is supplied to the furnace to heat the charge as rapidly as possible through the solidus-liquidus range so that the brazing material will melt completely. This alloy has a tendency to erode the stainless but controlling the amount used will limit this action.

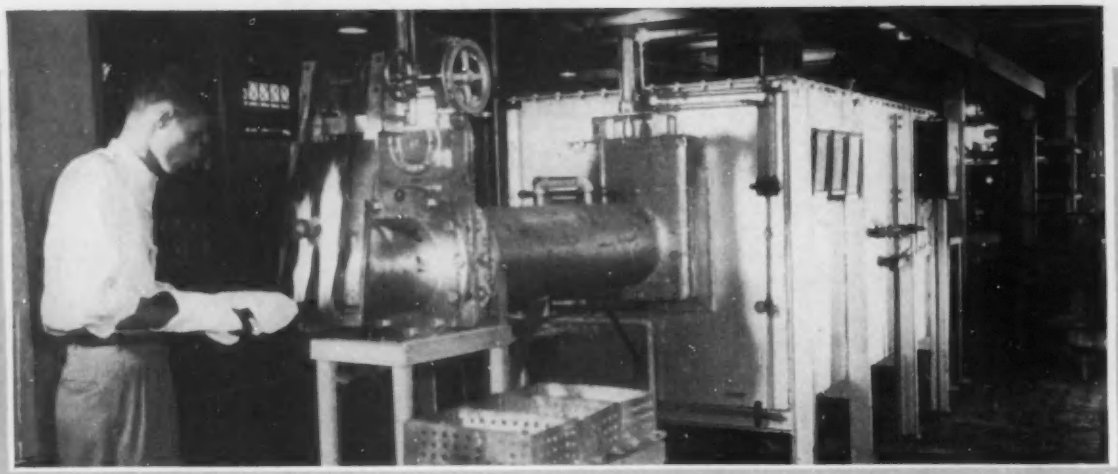
Another brazing material has been used with stainless and other high temperature alloys is 15 Si, 2 B, balance Ni. It flows well into the joints but gives poor fillets.

Copper is usually used for brazing stainless steel assemblies that are not used at elevated temperatures. Alloys such as 3 and 5 Ni Cu; 10 Ni, 5 Fe, 85 Cu; and 3 Co Cu can produce high tensile strength bonds.

The silver alloys, in general, will only wet iron, nichrome and stainless steels when heated to about 1100 C in dry hydrogen. Silver alloys with high zinc content show a tendency to intergranular attack of type 347 stainless. Some of the more satisfactory combinations which have been used are: 15 Mn Ag; Eutectic Ag Cu; 7Ag—85 Cu—8Sn; 65Ag—28Cu—5Mn—2Ni. An alcohol solution of nickel nitrate painted on the joint and brazed with silver alloys aids in the wetting of steel. The nitrate breaks down at very low temperature and the resulting nickel oxide is reduced very rapidly by the hydrogen. This leaves sponge nickel which furnishes capillary attraction for the molten metal and the nickel seems to act as a catalyst aiding in the clean-up of the stainless steel surface and in better wetting.

## IMPORTANCE OF DESIGN

The design of assemblies for brazing in dry hydrogen is about the same as used for furnace brazing in controlled atmospheres such as combusted gas, dissociated ammonia, and ordinary hydrogen. It is important that all joints be exposed to the circulation of the hydrogen to insure wetting by the



## DESCRIPTION OF THE PROCESS

The success of pure dry hydrogen brazing is dependent upon the maintenance of a low partial pressure of water vapor in the brazing atmosphere. The equilibrium between the atmosphere and the material to be brazed must be such that the reaction below or at the brazing temperature is always in the reducing direction. This is accomplished by using pure dry hydrogen with a dew-point of about —100 F and a closed retorted or retort type of furnace provided with a vent for circulation of the dry hydrogen. The dry hydrogen is produced by passing electrolytic hydrogen over a palladium coated ceramic at room temperature where any oxygen in the hydrogen combines with the hydrogen on the surface of the palladium to form water. The gas then passes through an activated alumina tower which removes the water and gives hydrogen of about —100 F dewpoint. Dry dissociated ammonia can also be used as a furnace atmosphere.

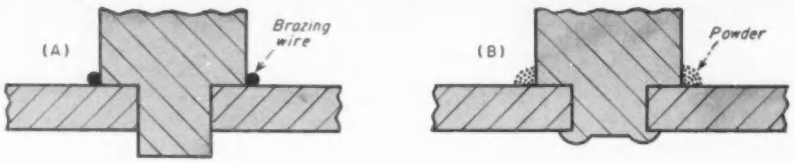



Fig. 2—Typical examples of joint design using brazing wire (A) and powder (B). The latter illustrates the use of punching to increase joint strength.

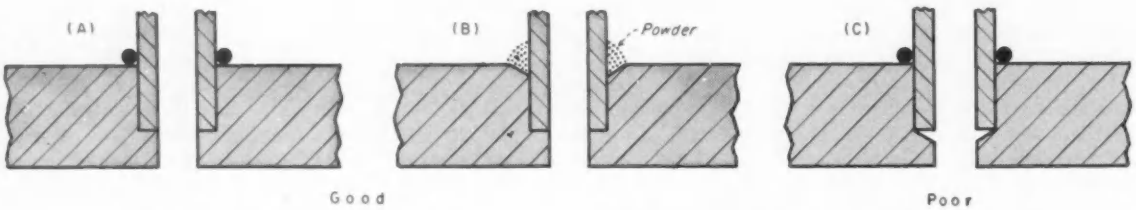



Fig. 3—For maximum strength, joint clearances should be 0.000-0.002 in. and mating surfaces should be clean and square, (A) and (B). Sketch (C) illustrates improper seating of male and female element.

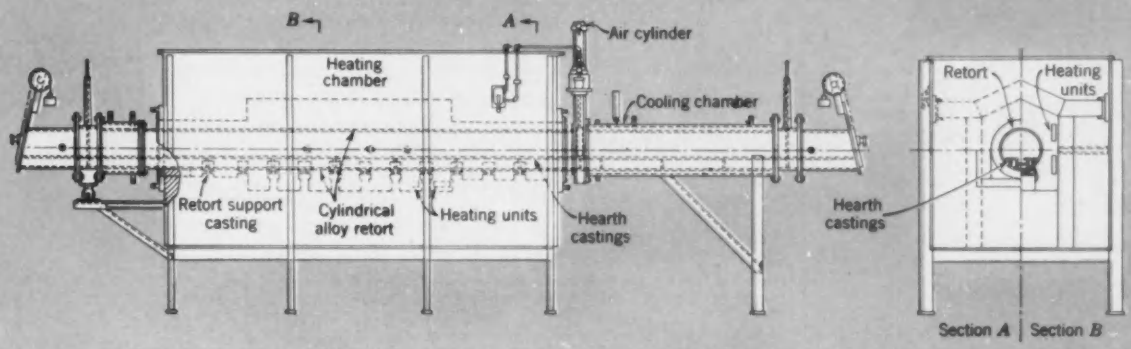
brazing material and clean bonds.

Many assemblies are simple such as shown in Fig. 2(A) and require only a push fit. Brazing material in wire form can be placed at the joint and the assembly brazed in an upright position. Upon melting, capillarity draws the liquid into the joint. When the function of the assembly requires greater strength, a punch may be driven into the tenon as shown in Fig. 2(B).

Some materials used for brazing high temperature alloys that are not ductile and cannot be fabricated into wire are used in powder form. The powder is mixed with alcohol to give a slurry or with a cellulose binder and painted on the joints.

In either method, it is essential to have well fitted joints with square corners on the female and male parts so that capillarity is continuous throughout the joint. Figs. 3(A) and (B) are typical illustrations. Fig. 3(C) shows the effect of a poorly fitted joint which prevents proper seating of the male element. Capillarity between the end of the male member and the seat in the female part is destroyed because of the distance between them. This reduces the brazed area and the strength of the joint.

Assemblies can be designed with a brazed area large enough to produce a shear strength in the joint which will




The parts to be brazed should be carefully cleaned by chemical methods, grit blasting, machining, grinding or wire brushing before assembly. Then, they are placed in a perforated tray which is introduced into the charging vestibule of a cylindrical alloy retort type of furnace, a sketch of which is shown below. The gate to the charging vestibule at the left end of the furnace is opened while the gate between it and the heating chamber is closed to prevent any air from entering the heating or brazing chamber. The charging vestibule is thoroughly purged and the gate between it and the heating chamber is opened. The hearth of the furnace consists of a series of castings placed end to end in the bottom of the alloy tube. The tray is pushed into the heating chamber where it is left for the desired brazing time and then pulled into the cooling chamber from the right end of the furnace. When cold, the gate between the cooling chamber and discharging vestibule at the right is opened. The tray is pulled into the discharging vestibule and the gate closed. The tray can then be removed by opening the gate at the right end of the furnace. No cleaning of parts is required.

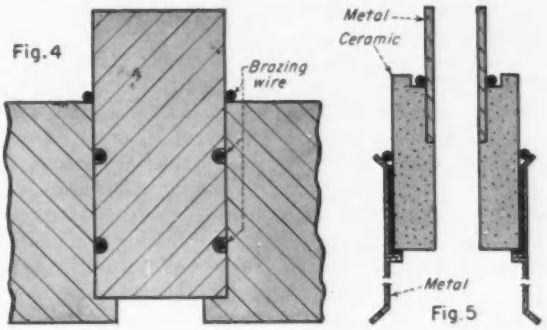
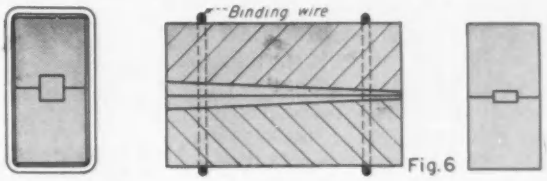



Fig. 4—With closely fitted joints, male or female member may require grooves as shown to provide adequate flow of brazing material. Were only one large piece of brazing wire used the chances of getting enough brazing area are poor.




Fig. 5—Illustration of brazing ceramic to low expansion metals such as nickel-iron and iron-nickel-cobalt. The seat for the ceramic is very important for without it the brazing alloy will not fill the joint. Also, the ceramic must be coated with titanium hydride before being assembled for bonding.

Fig. 6—Method for holding pieces with tapered slots. The two parts to be joined are put in a clamp and wired together with a low expansion metal such as 5 mil molybdenum wire. A piece of brazing wire is slipped under a turn of the binding wire at each end and held in place at the joint on each side.




exceed the tensile strength of the stressed member. With such applications, clearances between the members being joined must be very small typical values are 0.000-0.002 in. This allows the brazing material to flow in a very thin layer which alloys with the material to be brazed raising its melting point and preventing it from flowing through the joint. In such cases, the male or female member should be grooved as shown in Fig. 4 to make certain the liquid fills the joint.

When strength is not a prime requisite, the gap between parts can be 0.0015 to 0.003 in. The larger gap will restrict the alloying action in the thicker liquid layer. The brazing alloy will run farther and has a better chance of filling the joint before solidifying. However, joint strength decreases rapidly with increasing bond thickness. Under no circumstances can the gap between parts exceed 0.004 in.

Another important design aspect is that the mating parts must be held rigidly during heating. If adequate support cannot be provided by proper design of the parts themselves, Fig. 5, clamping may be required. For example, Fig. 6, shows a method for holding pieces with tapered slots in proper alignment. In other applications, assemblies have been held together by tack welding, spot welding, pinning and riveting.

Table I—Relative Strengths of Unbrazed and Brazed Materials

| Material | Heat Treatment | Room Temp. Strength, psi |
|---|---|---|
| (AISI 403), Blank Sample | Heated to 1200 C (2192 F) in 20 min. and pushed into water cooling chamber. | 200,000 |
| (AISI 431), Blank Sample | Quenched and stress relieved. | 190,000 |
| (AISI 431), Nicrobraz | Quenched and stress relieved. | slightly over 190,000 |
| (AISI 403), Cu Ni Fe Brazed | Heated to 1200 C (2192 F) in 20 min. and cooled in water cooling chamber in $H_2$ | 139,900 |
| (AMS 5770) (S 590) Blank | Heated to 1177 C (2150 F) in 30 min. and aged at 760 C (1400 F) for 16 hrs. | 137,000 |
| (AISI 403) 3% Co Cu Brazed | Heated to 1200 C (2192 F) in 20 min. and cooled in water cooling chamber in $H_2$. | 124,000 |
| (AMS 5770) (S 590) Nicrobraz | Heated to 1177 C (2150 F) in 30 min. and aged at 760 C (1400 F) for 16 hrs. | 121,500 |
| (AISI 403) Cu Ni Fe Brazed | Heated to 1200 C (2192 F) in 20 min. and cooled in water cooling chamber. Reheated in air to 950 C (1742 F) oil quenched, drawn at 600 C (1112 F) and air cooled. | 119,400 |
| (AISI 403) Cu Brazed | Heated to 1200 C (2192 F) in 20 min. and cooled in water cooling chamber, in $H_2$. | 118,900 |
| (AISI 403) Blank | Heated in air to 950 C (1742 F) oil quenched and drawn at 600 C (1112 F) in air, air cooled. | 111,400 |
| (AISI 403) Cu Ni Fe Brazed | Heated to 1200 C (2192 F) in 20 min. and cooled in water cooling chamber. Reheated in dry $H_2$ to 950 C (1742 F) oil quenched and drawn at 600 C (1112 F) in dry $H_2$ and air cooled. | 107,400 |
| (AMS 5770) (S 590) Cu Brazed (AMS 5646) | Heated to 2050 F in 15 min. and aged at 760 C (1400 F) for 16 hrs. | 102,000 |
| (AISI 347) Nicrobraz (AMS 5646) | Heated to 1177 C (2150 F) in 30 min. and aged at 760 C (1400 F) for 16 hrs. | 89,800 |
| (AISI 347) Blank | Heated to 1177 C (2150 F) in 30 min. and aged at 760 C (1400 F) for 16 hrs. | 88,900 |
| (AMS 5770) (S 590) 15 Mn Ag Brazed | Heated to 1177 C (2150 F) in 30 min. and aged at 760 C (1400 F) for 16 hrs. | 80,000 |
| Timken Brazed to Vitallium — with Nicrobraz | H. F. Induction heated to 1150 C (2100 F) in 10 min. in quartz tube. Cooled in dry $H_2$. | 80,000 |

## JOINT STRENGTH

As mentioned previously, the clearance between mating parts is an important strength factor. Obviously, the physical properties of the base and brazing material are also significant. At elevated temperatures, other considerations are grain growth, grain size, diffusion, and alloying action of brazing material with base metal.

The data in Table I give some indictation of relative strengths of butt brazed joints using several brazing alloys and dry hydrogen. The tensile properties of the unbrazed blanks of AISI 403 and 431 steels put through the brazing cycle indicate that they are heat-treatable. It is noteworthy that the tensile strength of the Nicrobraz 431 steel has a tensile strength at room temperature slightly above that of the unbrazed material. The fact that the brazing material has alloyed with the 431 steel to form a new alloy is probably the best explanation for it.

This alloying action in the case of 347 stainless Nicrobraz at 1100 C for 10 minutes in dry hydrogen is illustrated in Fig. 7. The type 403 material brazed with 85Cu-10 Ni-5 Fe alloy has room temperature strength of 139,900 psi. When brazed with copper, 118,900 psi. Both were cooled in water chamber after brazing which is equivalent to a quench. The brazing materials have no such strengths and are not heat-treatable and the alloying action is not sufficient to account for the results. The Cu-Ni-Fe brazed 403 material when quenched and drawn still had a tensile strength of 119,400 psi. Nicrobraz S 590 material after heat-treatment has a room temperature strength of 121,500 psi, but the tensile strength of 25,800 psi at 1800 F is outstanding.

The 15 Mn Ag brazed S 590 material heat-treated had the lowest strength at room temperature, 80,000 psi, of any of the materials tested. It seems that the strength at room temperature of a steel brazed with any brazing material which does not produce a new alloy at the joint is dependent upon the heat-treatment of the steel. If the joint clearances are controlled closely and the brazing material is thin, nothing happens to the brazing material when subjected to a tensile stress until the steel yields. Then the tensile specimen fails through the brazed joint; the brazing material is so thin that it cannot neck down. The steel on either side prevents its movement but, when the steel yields, the brazing material is allowed to move and rupture occurs in the brazed joint. When brazing material is thick, it can move independently of the steel and failure occurs at a stress far below the steel yield point.

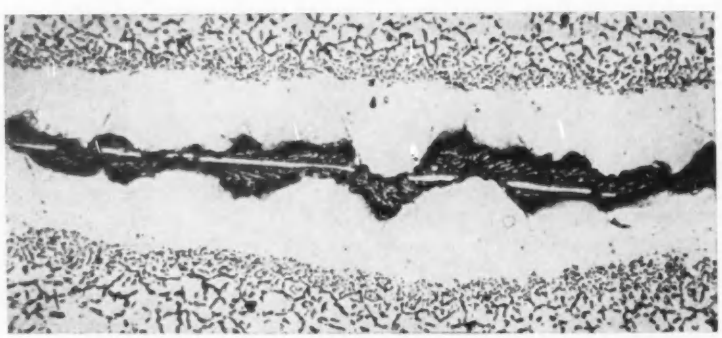


Fig. 7—Typical joint in 347 stainless Nicrobrazed at 1,100 C in pure hydrogen illustrates the alloying action that takes place between the brazing and base material. In many cases, the result is a bond that is stronger than either the brazing material or the base metal when taken alone.

FIRST STEP in the design of critical load carrying structures of glass fabric laminates is to establish property values under service conditions.

EUGENE McLAUD
FRANK GUSTAFSON
Structural Development Engineers,
Boeing Airplane Company

**High strength-weight ratio and low tool costs have fostered application of glass fabric laminates for structural use, but for a stronger competitive position with light alloys, more uniformity in properties is required. Tests reported here show the effect of number of plies, contour and thickness, temperature and humidity on the properties of one type of laminate.**

# *Design Limits for*

# Polyester-Glass Laminates

THE GROWING STRUCTURAL APPLICATION of reinforced plastics, or glass fabric laminates, has instituted an urgent need for determining design limits. In the design of critical load-carrying structures of glass fabric laminates, two factors are significant: first, uniform mechanical properties of a particular laminate under load, and second, allowable design properties for the material. Data on these factors have been lacking; now, design properties for one polyester glass fabric laminate have been determined, establishing that:

1. Stress and modulus are dependent on resin content. Designs

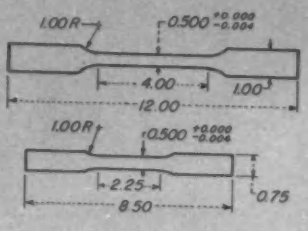
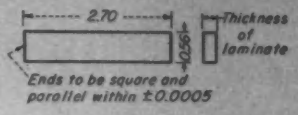
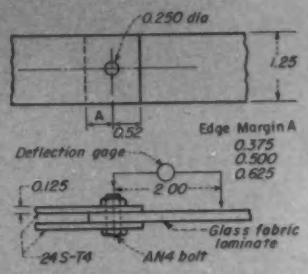
| Test | Tensile | Compression | Flexure |
|---|---|---|---|
| Preparation and Procedure | Specimen preparation by ASTM practice; machined by milling, water coolant. Load applied at 300 lb/min. | Sheet Specimen; 2.70: in. long x .56 in. wide x thickness of laminate. | Specimens 6 in. long, 1 in. wide; loaded as simple beam with load concentrated at mid-span. Load deflection data taken at regular increments. |
| Equipment | 120,000 lb Baldwin Southwark Hydraulic tester, Templin self aligning grips; Load strain obtained with Templin autographic recorder, 2 in. gage length extensiometer. | 120,000 lb hydraulic tester; sheet tested in roller type jig, NACA technical note No. 819. Load-strain obtained with equipment above; deformation measured by precision dial indicators. | Supports were rollers located 4 in. apart; load transmitting tool, located at specimen center, was radiused ⅛ in. |
| Test Specimen |   |   |   |

Fig. 1—Test equipment and procedures used in investigating mechanical properties of polyester glass laminate under temperature, humidity, and weathering exposure. Laminates were manufactured in accordance with USAF 12051 Specification as Type III, Class III materials. Test specimens were taken from laminated panels approximately 24 in. by 36 in. in size. All panels were processed "void-free."

should be based on number of fabric plies rather than thickness.

2. Specimen shape has an appreciable effect on mechanical properties, measured in test.

3. After exposure to weathering, fabric laminates with a silane finish have physical properties superior to those of laminates finished with chrome complex.

4. Properties of cross-laminated material can be predicted with good accuracy.

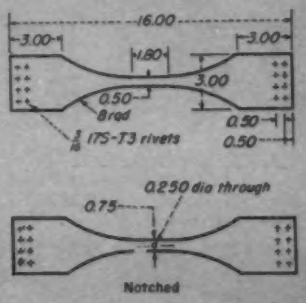
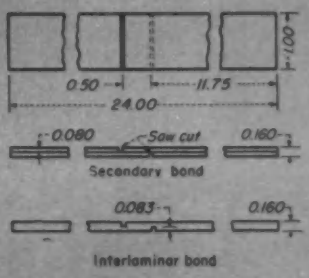
5. There is no direct correlation between the flexural and tensile or compressive properties of a laminate.

6. Static ultimate strength is an acceptable basis of design for structures subjected to repetitive loads and stress concentration.

7. Bond shear strength is substantially that of the resin alone.

MECHANICAL PROPERTIES. The particular laminate tested in this investigation was processed "void-free," consisting of 182 glass fabric, an 8-harness satin weave, and a polyester type resin binder, Rohm & Haas' Paraplex P-43. Fabric finishes were Garan silane and 114 chrome complex. Each of the laminate's mechanical properties under exposure and temperature was investigated, Fig. 1, including tension, compression, flexure, bearing, fatigue, interlaminar bond shear, and bond shear. These tests confirm that glass fabric laminate test results are subject to a large number of variables (*Product Engineering*, May 1954) which stem from materials used, fabrication procedure, machining of specimens, specimen size and configuration, and testing procedures. A significant variation, for example, was displayed in two groups of three supposedly identical specimens which varied in average ultimate stress from 40,200 to 47,100 psi—even after these values had been corrected for thickness per ply. The variation in all of the Garan finish panels is from 40,200 to 49,800 psi, and in the 114 finish panels from 39,000 to 53,900 lb per sq inch.

TENSION. Ultimate stress and modulus of elasticity decrease with increased thickness per ply, a factor of increased

| Bearing | Fatigue | Bond Shear | Relative humidity | Temp. |
|---|---|---|---|---|
| Deflections measured, from bolt to 2 in. away, taken as hole deformation; negligible strain not considered; for bearing stresses, area was product of pin diameter and laminate thickness; yield strength taken at 4 percent offset of pin diameter, 0.010 from str. line position of deflection curves. | Axial tension repeated loads of sheet laminate; pin-connected at lower end to vibrating beam, upper end to calibrated dynamometer; specimens wrapped with wet cloths to maintain cooling and humidity | Slots, ½ in. apart, cut on each side; depth of cut separated glass fiber leaving resin bond intact; when specimen was stressed in tension, resin bond was shear loaded. | Maintained at 100 percent; temp. 125F. | Held to ±15 deg of 125F, 160F, and 200F. |
| Dial indicators | Resonant beam fatigue machine; loads measured with strainometer and oscillograph. | | Humidity cabinet | Temperature cabinet |
|  | |  | | |

resin content. When tensile control stress and modulus are compared, Fig. 2, the trend of average stress or modulus values changes from the negative slope in the original instance to an essentially zero slope for the re-evaluated data. This established a nominal thickness per ply of 0.014 in. for 182 fabric. Specimen fillet radius, as well as thickness per ply, has a noticeable affect on tensile strength. Fig. 3 shows the realtive improvement in ultimate tensile strength possible with an increase of the fillet radius from 1 in. to 3 in.

COMPRESSION. Length to width ratio also influences strength by imposing various amounts of edge restraint on a material. In testing, a thin specimen exhibits properties of no edge restraint; a wide specimen approaches a condition of complete edge restraint.

The edge restraint effect is noticeable only when the laminate is being stressed at an angle to the warp other than 0 or 90 deg. At 45 deg to the warp in compression, for example, the effect of loading a narrow specimen is to produce an angular displacement of the fibers. This displacement would be much less pronounced with a wider specimen and would presumably be completely eliminated in a specimen of infinite width.

FLEXURE. There is no direct correlation between flexure and tension or compression test properties. Fig. 4 shows a typical stress-deflection curve for these polyester-glass fabric laminated plastic materials.

FATIGUE. This glass fabric laminate reaches an endurance limit at approximately 20 percent of the ultimate strength. Notched specimens exhibit equal or higher fatigue strengths than unnotched specimens, based on a percentage of ultimate static strength.

Typical fatigue failures were experienced at 0 and 90 deg to the warp. At 45 deg, however, the material did not break at failure. Instead, the resin or resin-to-glass bond apparently failed, resulting in a softening and excessive stretching of the material. This resin breakdown is a result of the "scissoring" action of the glass fibers at 45 deg to the warp under a cyclic load.

BEARING CHARACTERISTICS. Bearing tests using edge margins of 1.5$D$, 2$D$ and 2.5$D$ ($D$ = diameter of pin) were conducted on unweathered 114 finish laminates at 90 deg to the warp. Check tests were also performed on unweathered 114 finish laminates at 45 deg to the warp, and on unweathered Garan finish laminates at 90 deg to the warp,

using edge margins of 2*D*. Bearing tests were also conducted on 114 finish laminates at both 90 and 45 deg to the warp after twenty-eight days of humidity exposure, and on Garan finish laminates at 90 deg to the warp after thirty days of humidity exposure, using in each instance an edge margin of 2*D*. The curves, Fig. 5, of the 114 finish data after exposure and of the Garan data both before and after exposure, were extrapolated, assuming the same percentage decrease at edge margins of 1.5*D* and 2.5*D* as was experienced at 2*D*.

WEATHERING CHARACTERISTICS. In the accelerated weathering tests conducted on this glass fabric laminate to establish resistance limits to heat, cold and relative humidity, humidity exposure—without a cold cycle—proved most deleterious to the material. Humidity exposure curves, Fig. 6, point up the marked superiority of Garan finish fabrics over 114 finish fabrics, particularly at 45 deg to the warp. Initially, the ultimate tensile strength of the Garan finish fabric at 45 deg to the warp was lower than that of the 114 finish fabric at 90 deg to the warp, but this discrepancy can be attributed to the combination of variables in laminating and testing.

The test results on cross-laminated glass fabric, consisting of 14 plies—with the warp direction of the center four plies 45 deg to the warp direction of the outer plies, concur fairly well with theoretical predictions, Fig. 7. The values called theoretical are not derived from true theory but are the result of values combined with those from a test of parallel laminated materials. For example:

$$10F_{t90} + 4F_{t45} = 14F_{tx90}$$

where:

$F_{t90}$ = tensile stress, psi, of parallel laminate at 90 deg to the warp.

$F_{t45}$ = tensile stress, psi, of parallel laminate at 45 deg to the warp.

$F_{tx90}$ = tensile stress, psi, of given cross laminate at 90 deg to the warp.

The modulus of elasticity of this glass fabric laminate follows essentially the same trend as that of tensile stress. The Garan finish fabric again is indicated as the stronger material, Fig. 8. Even in machined panels, where moisture absorption was greater along the edges with only limited penetration of the surface, tensile stress and modulus of elasticity decreased in approximately the same percentage. In a panel with only the edges protected with a moisture-resistant coating, tensile stress decreased 13.7 percent, and modulus of elasticity, 7.2 percent. In a completely coated panel, the decrease in tensile strength was 9.9 percent and in modulus, 5.7 percent, clearly indicating the need for protecting all machined edges and surfaces of 114 finish laminates with a moisture resistant coating.

In compression at 90 deg to the warp, the loss of strength of these laminates incurred by weathering is much more severe than in tension. The improvement in strength retention afforded by the Garan finish as against the 114 finish is, therefore, proportionately greater in compression.

TEMPERATURE. The behavior of Garan and 114 finish laminates under elevated temperature compression tests parallels that of these materials subjected to weathering. A comparison of ultimate compressive stress values, Fig. 9, with

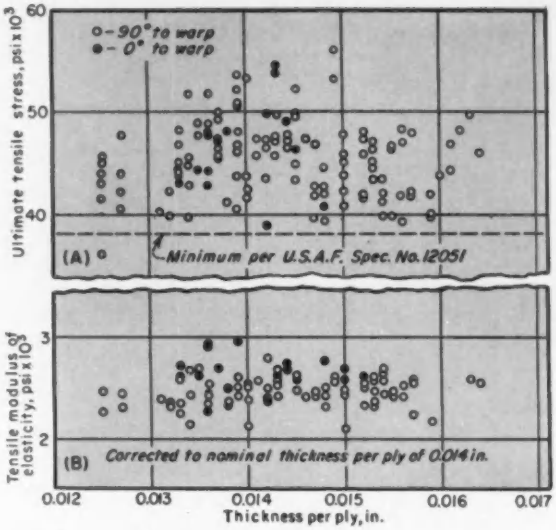

Ultimate tensile stress, psi x 10³
o - 90° to warp
● - 0° to warp
(A)
Minimum per U.S.A.F. Spec. No. 12051
Tensile modulus of elasticity, psi x 10⁶
(B)
Corrected to nominal thickness per ply of 0.014 in.
Thickness per ply, in.

Fig. 2—Comparison of ultimate stress and modulus of elasticity with thickness of laminate imparted by resin content.

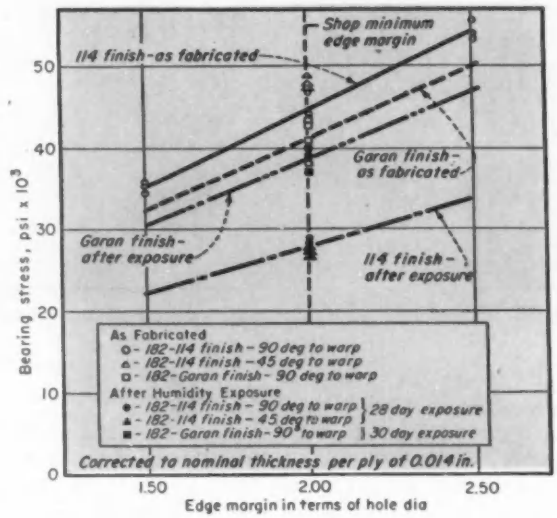

Shop minimum edge margin
114 finish-as fabricated
Garan finish-as fabricated
Garan finish-after exposure
114 finish-after exposure
As Fabricated
o - 182-114 finish - 90 deg to warp
△ - 182-114 finish - 45 deg to warp
□ - 182-Garan finish - 90 deg to warp
After Humidity Exposure
● - 182-114 finish - 90 deg to warp } 28 day exposure
▲ - 182-114 finish - 45 deg to warp }
■ - 182-Garan finish - 90° to warp } 30 day exposure
Corrected to nominal thickness per ply of 0.014 in.
Bearing stress, psi x 10³
Edge margin in terms of hole dia

Fig. 5—Bearing edge margin test data for polyester glass fabric laminates.

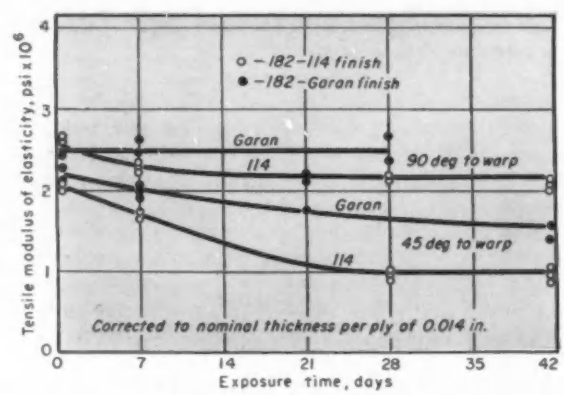



Fig. 8—Effect of humidity exposure on tensile modulus.

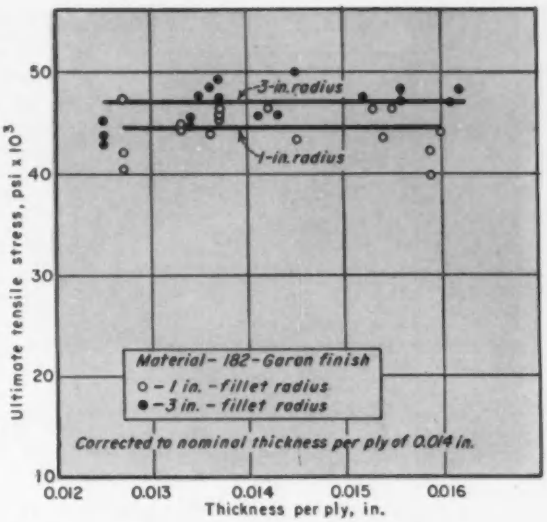

3-in. radius
1-in. radius
Material - 182 - Garan finish
○ - 1 in. - fillet radius
● - 3 in. - fillet radius
Corrected to nominal thickness per ply of 0.014 in.
Ultimate tensile stress, psi x 10³
Thickness per ply, in.

Fig. 3—Effect of fillet radius on ultimate tensile strength of polyester glass laminate. Liberal radius is indicated.

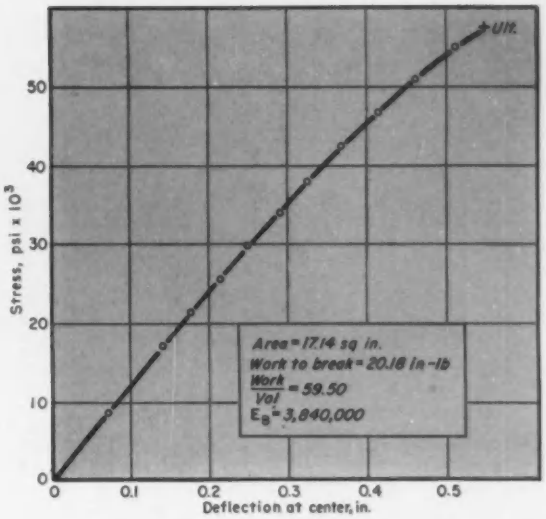



Fig. 4—Typical stress-deflection curve for polyester glass fabric laminated materials.

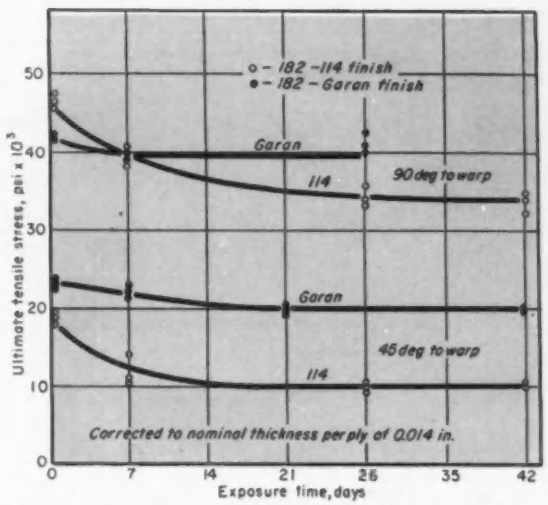



Fig. 6—Effect of humidity exposure on ultimate tensile stress in polyester glass fabric laminate.

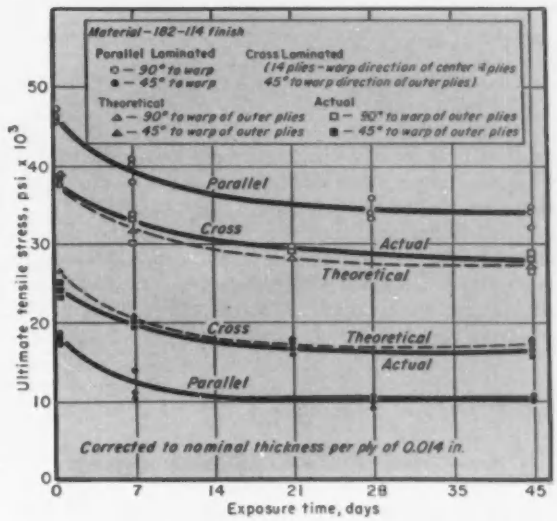

Material - 182 - 114 finish
Parallel Laminated
○ - 90° to warp
● - 45° to warp
Cross Laminated
(14 plies - warp direction of center 4 plies 45° to warp direction of outer plies)
Theoretical
△ - 90° to warp of outer plies
▲ - 45° to warp of outer plies
Actual
□ - 90° to warp of outer plies
■ - 45° to warp of outer plies
Parallel
Cross
Actual
Theoretical
Cross
Theoretical
Actual
Parallel
Corrected to nominal thickness per ply of 0.014 in.
Ultimate tensile stress, psi x 10³
Exposure time, days

Fig. 7—Effect of humidity exposure on parallel and cross-laminated glass fabric laminates.

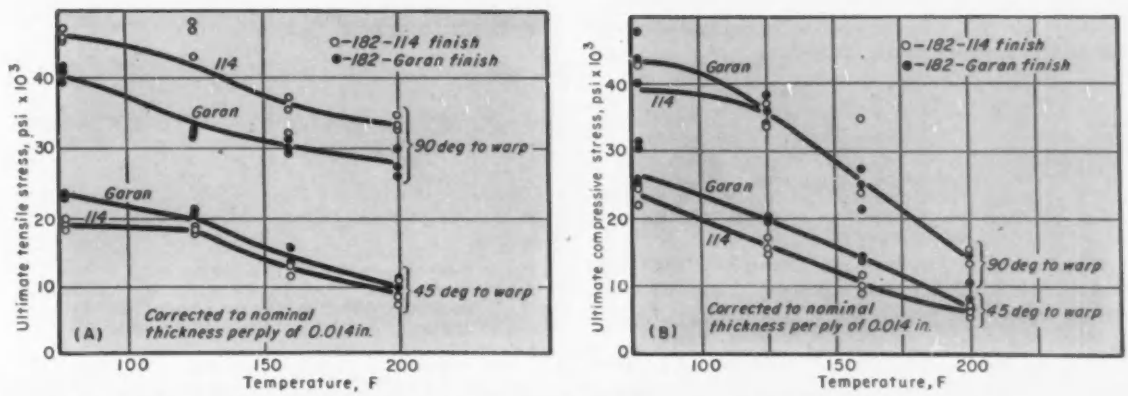
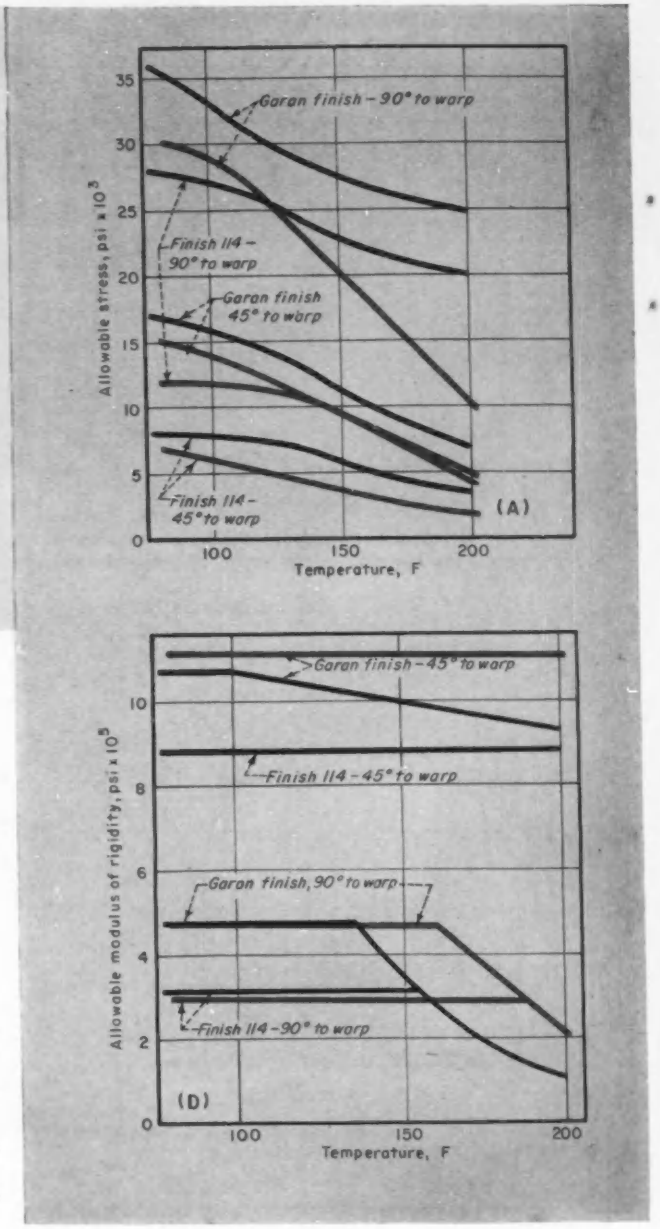



Fig. 9—Effect of temperature on (A) ultimate tensile stress for glass fabric laminates, (B) ultimate compressive stress.

**Table I—Room Temperature Allowable Properties for Glass Fabric Laminates**

| Property | Deg to warp | Garan Silane Finish | 114 Chrome Complex Finish |
|---|---|---|---|
| Tensile Stress, psi | 0 or 90 | 36,000 | 28,000 |
| | 45 | 17,000 | 8,000 |
| Compressive Stress, psi | 0 or 90 | 30,000 | 12,000 |
| | 45 | 15,000 | 7,000 |
| Shear Stress, psi | 0 or 90 | 8,040 | 3,850 |
| | 45 | 21,200 | 8,500 |
| Bearing Stress, psi | | 34,000 | 29,000 |
| Secondary—Interlaminar Bond Shear Stress, psi | | ..... | 650 |
| Tensile or Compressive Modulus of Elasticity, psi | 0 or 90 | 2,500,000 | 2,060,000 |
| | 45 | 1,450,000 | 1,000,000 |
| Modulus of Rigidity, psi | 0 or 90 | 473,000 | 298,000 |
| | 45 | 1,078,000 | 888,000 |
| Net Area Efficiency, percent | | 50 | 50 |


Garan finish – 90° to warp
Finish 114 – 90° to warp
Garan finish 45° to warp
Finish 114 – 45° to warp
(A)
Allowable stress, psi x 10³
Temperature, F
Garan finish – 45° to warp
Finish 114 – 45° to warp
Garan finish, 90° to warp
Finish 114 – 90° to warp
(D)
Allowable modulus of rigidity, psi x 10⁵
Temperature, F

tensile curves reveals that the proportionate decrease in strength is much greater in compression than in tension. In tension, glass fibers will absorb the load after the resin has failed, but in compression, failure of the resin is accompanied by buckling of the glass fibers. The strength of the resin, therefore, and the resin-to-glass bond, have greater effect on laminate strength in compression than in tension.

## *Establishing Design Criteria*

Upon such test data can design criteria be built, for room temperature service, Table I, and Fig. 10, elevated temperature service. The first step in the determination of these values established a minimum acceptable control value for each property of the unweathered laminate. For tensile stress at 90 deg to the warp, USAF Specification No. 12051 specifies 38,000 psi. This was found by auxiliary testing to be acceptable. For all other conditions, the acceptable control value was determined as follows:

$$F_{min} = F_t \times \frac{38{,}000}{F_{t90}}$$

where:

$F_{min}$ = minimum acceptable control stress, psi
$F_t$ = average control test stress, psi, for the given condition.
$F_{t90}$ = average control tensile test stress, psi, at 90 deg to the warp for the same panel.

Where a specific condition had been tested from more than one panel, the minimum acceptable control stress was determined from an average of the control values for each panel.

After the minimum acceptable control stress is determined, room temperature allowable stresses can be derived by reducing the average value of weathered specimens by the ratio of minimum acceptable control stress to average actual control stress:

$$F_{all} = F_{wea}\left(\frac{F_{min}}{F_{act}}\right)$$

where:

$F_{all}$ = room temperature allowable stress, psi.
$F_{wea}$ = average test stress, psi, at which the laminate approaches equilibrium after exposure to weathering conditions.
$F_{min}$ = minimum acceptable control stress, psi.
$F_{act}$ = average actual control stress, psi.

Because the properties of glass fabric laminates decrease upon exposure to elevated temperatures, modification of

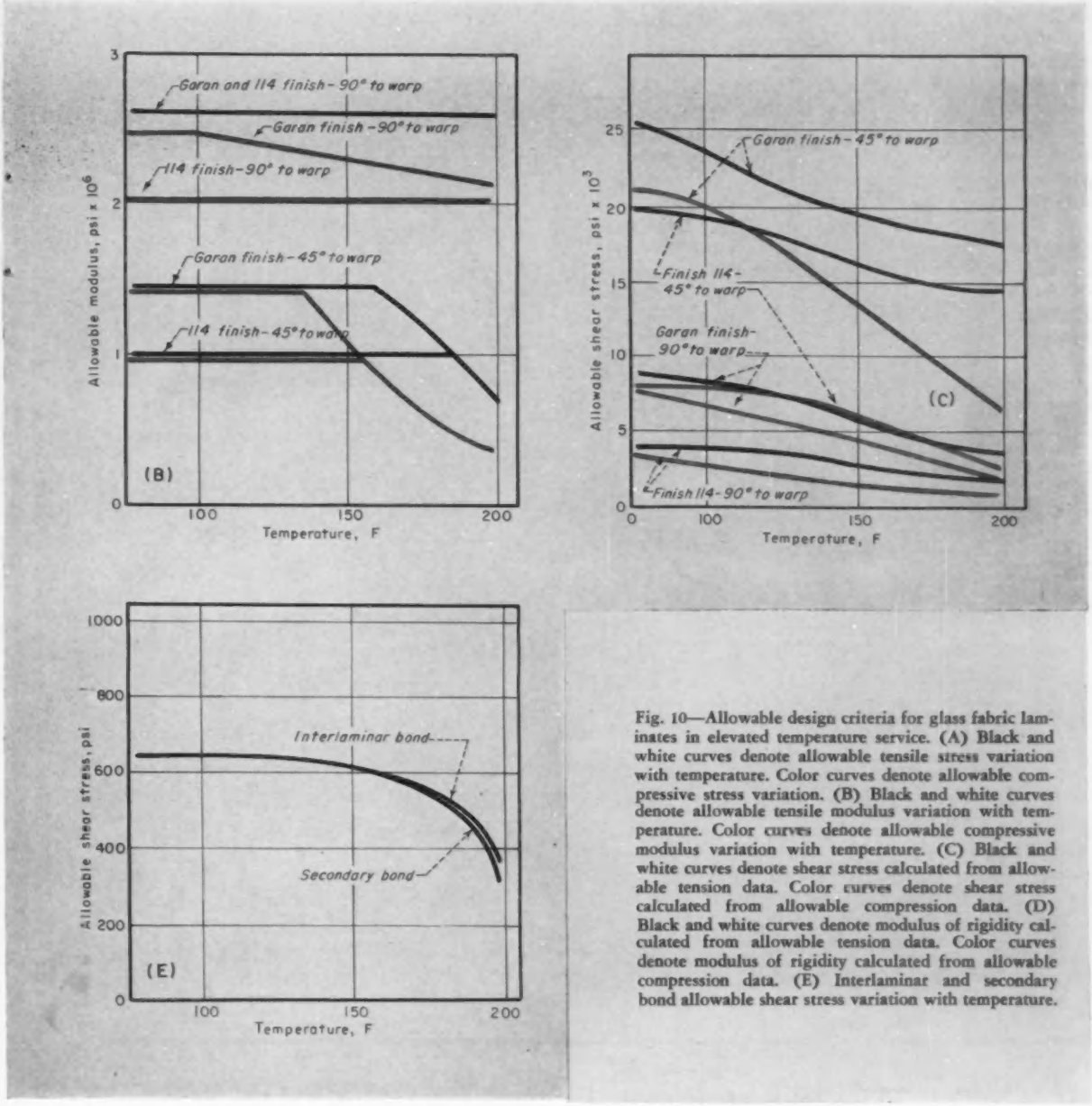

Garan and 114 finish - 90° to warp
Garan finish - 90° to warp
114 finish - 90° to warp
Garan finish - 45° to warp
114 finish - 45° to warp
(B)
Allowable modulus, psi x 10⁶
Temperature, F
Garan finish - 45° to warp
Finish 114 - 45° to warp
Garan finish - 90° to warp
(C)
Finish 114 - 90° to warp
Allowable shear stress, psi x 10³
Temperature, F
Interlaminar bond
Secondary bond
(E)
Allowable shear stress, psi
Temperature, F

**Fig. 10—Allowable design criteria for glass fabric laminates in elevated temperature service. (A) Black and white curves denote allowable tensile stress variation with temperature. Color curves denote allowable compressive stress variation. (B) Black and white curves denote allowable tensile modulus variation with temperature. Color curves denote allowable compressive modulus variation with temperature. (C) Black and white curves denote shear stress calculated from allowable tension data. Color curves denote shear stress calculated from allowable compression data. (D) Black and white curves denote modulus of rigidity calculated from allowable tension data. Color curves denote modulus of rigidity calculated from allowable compression data. (E) Interlaminar and secondary bond allowable shear stress variation with temperature.**

the room temperature allowables is necessary where elevated temperature exposure exists. This is accomplished in two steps:

1. The test stress at temperature is reduced by the ratio of the minimum acceptable control stress to the average actual control stress:

$$F_{corr} = F_{temp}\left(\frac{F_{min}}{F_{act}}\right)$$

where:

$F_{corr}$ = corrected average test stress, psi, at temperature.
$F_{temp}$ = actual average test stress, psi, at temperature.
$F_{min}$ = minimum acceptable control stress, psi.
$F_{act}$ = average actual control stress, psi.

2. The corrected average test stress at temperature is then adjusted to compensate for weathering exposure by the ratio of the room temperature allowable stress to the minimum acceptable control stress:

$$F_{all\text{-}T} = F_{corr}\left(\frac{F_{all}}{F_{min}}\right)$$

where:

$F_{all\text{-}T}$ = allowable stress, psi, at given temperature.
$F_{corr}$ = corrected average test stress, psi, at temperature.
$F_{all}$ = room temperature allowable stress, psi.
$F_{min}$ = minimum acceptable control stress, psi.

The room temperature moduli of elasticity are determined

from the humidity exposure curves by selecting the value at which the modulus approaches equilibrium. For elevated temperature conditions, the room temperature modulus is combined with the modulus curves at elevated temperature, assuming that the room temperature modulus would be effective until its intersection with the temperature curve.

Where available test methods are inadequate in obtaining ultimate shear strength and modulus of rigidity in the plane of the shear, the shear stresses and moduli of rigidity can be calculated. Those shown in Fig. 10 are based on the equations proposed in Forest Products Laboratory Report No. 1803. Their development as used in this evaluation is the following:

1. Shear stress parallel or perpendicular to warp takes the form:

$$\frac{1}{F_x^2} = \frac{\cos^4\theta}{F_a^2} + \frac{\sin^4\theta}{F_b^2} + \frac{\sin^2\theta\cos^2\theta}{F_{ab}^2}$$

where:

$\theta$ = angle between warp direction and load
$F_x$ = stress in direction of load
$F_a$ = tensile stress of laminate parallel to warp
$F_b$ = tensile stress of laminate perpendicular to warp
$F_{ab}$ = shear stress of the laminate in plane of $a$-$b$

If

$$F_x = F_{ab}, \qquad \text{then} \qquad \theta = 45 \text{ deg}$$

and

$$\cos^4\theta = \sin^4\theta = \sin^2\theta\cos^2\theta = 1/4$$

and assuming $F_a = F_b$, then

$$\frac{1}{F_x^2} = 1/4\left(\frac{2}{F_b^2} + \frac{1}{F_{ab}^2}\right)$$

and

$$\frac{4}{F_x^2} = \frac{2}{F_b^2} + \frac{1}{F_{ab}^2}$$

or

$$\frac{1}{F_{ab}^2} = \frac{4}{F_x^2} - \frac{2}{F_b^2}$$

By substituting the values obtained in tension or compression test of laminates at 45 deg and 90 deg to warp for $F_x$ and $F_b$, the corresponding shear stresses are obtained.

2. Shear stress at 45 deg to warp is:

$$\frac{1}{F_{xy}^2} = \frac{1}{F_{ab}^2}\cos^2 2\theta + \left(\frac{1}{F_a^2} + \frac{1}{F_b^2}\right)\sin^2 2\theta$$

where:

$F_{xy}$ = shear stress in the $xy$ plane, 45 deg to warp.

If

$$\theta = 0 \text{ deg or } 90 \text{ deg}, \quad \sin^2 2\theta = 0 \quad \text{and} \quad F_{xy} = F_{ab}$$

or if

$$\theta = 45 \text{ deg}, \qquad \cos^2 2\theta = 0$$

and

$$\frac{1}{F_{xy}^2} = \frac{1}{F_a^2} + \frac{1}{F_b^2} = \frac{2}{F_b^2}$$

3. Modulus of rigidity parallel or perpendicular to warp is:

$$\frac{1}{E_x} = \frac{1}{E_a}\cos^4\theta + \frac{1}{E_b}\sin^4\theta + \left(\frac{1}{U_{ab}} - \frac{2\sigma ab}{E_a}\right)\sin^2\theta\cos^2\theta$$

where:

$U_{ab}$ = modulus of rigidity in the $a$-$b$ plane
$\sigma_{ab}$ = Poisson's ratio = 0.16
From Forest Products Laboratory Report No. 1803.

Let

$$E_x = E_{45}, \qquad \theta = 45 \text{ deg} \qquad \text{and} \qquad E_a = E_b.$$

Then

$$\frac{1}{E_x} = 1/4\left(\frac{2}{E_b} + \frac{1}{U_{ab}} - \frac{0.32}{E_b}\right) = 1/4\left(\frac{1.68}{E_b} + \frac{1}{U_{ab}}\right)$$

$$\frac{4}{E_x} = \frac{1.68}{E_b} + \frac{1}{U_{ab}}$$

$$\frac{1}{U_{ab}} = \frac{4}{E_x} - \frac{1.68}{E_b}$$

4. Modulus of rigidity at 45 deg to warp is:

$$\frac{1}{U_{xy}} = \frac{1}{U_{ab}}\cos^2 2\theta + \left(\frac{1}{E_a} + \frac{1}{E_b} + \frac{2\sigma_{ab}}{E_a}\right)\sin^2 2\theta$$

where:

$U_{xy}$ = modulus of rigidity in the $x$-$y$ plane (45 deg to warp).

If

$$\theta = 0 \text{ deg} \quad \text{or} \quad 90 \text{ deg} \sin^2 2\theta = 0 \quad \text{and} \quad U_{xy} = U_{ab}$$

or if

$$\theta = 45 \text{ deg}, \qquad \cos^2 2\theta = 0$$

and

$$\frac{1}{U_{xy}} = \frac{2}{E_b} + \frac{0.32}{E_b} = \frac{2.32}{E_b}$$

Each of the equations above is derived for the case of no restraint, which is considered the most conservative viewpoint.

# ENGINEER SHORTAGE SPEEDS AUTOMATION

THE PRESENT DAY SHORTAGE of engineers has always been a topic of conversation, but according to David Rubinfien, supervisor of the Computer center at Armour Research Foundation of the Illinois Institute of Technology, the effect of the shortage will be to push the automatic factory or office into reality.

The need for engineering personnel already has been alleviated by computing machines, he said, and the electronic calculators will also remove from most engineering activity a dull routine that caused the failure of many projects in the past. Other factors in evidence which will bring about the increased use of automation are the inability of humans to perform certain jobs with adequate speed, the lack of safety in some industrial activities, and the high cost of human participation in some factory areas.

Special purpose machines to perform all the operations necessary in completing a given product have been used for many years—the canning and bottling, the automatic automobile production lines, and the continuous strip steel mills are a good example—but automation clearly goes further. Says Rubenfien, "It is a set of techniques for achieving the automatic plant, designed to minimize human participation in all of its phases. A better answer lies in the automatic control of separate and group processing. Automation would position both the tools and work according to a flexible set of instructions. The flow of work and tools between machine also would be electronically controlled."

A. V. Roe Canada Ltd.

# *How Quality Control Can Affect*

# Casting Costs

ROLAND N. LAVEEN

San Diego Div.,
Consolidated Vultee Aircraft Corp.

MANY PARTS CAN BE PRODUCED by one of several different methods and still satisfy service requirements. In such applications, the decision to forge, cast or fabricate is influenced, and sometimes decided, by the economics involved.

For castings, reliable cost data for such well-known items as patterns, molds, jigs and fixtures, machining and other routine processes are readily available. But this is not true for the quality control operations, techniques and equipment that are peculiar to the casting process. Most designers are aware of the existence of these factors but many do not appreciate how important a part they can play in a cost analysis. What is more, this information is not readily available when its need is recognized by the engineer.

This situation has received particular emphasis in the aircraft industry where military and civil specifications require that all castings be subject to various inspection and test procedures. As shown in Table I, each casting is classed according to its use on the aircraft and the ratio of strength to maximum applied load; Table II gives the various quality control requirements for each class. Also given in this table

are typical current cost data for each of the operations. The factors that have been included in these operations are as follows:

**Drafting.** Additional engineering drawing time needed to add a sketch to the face of the casting drawing to indicate the high and low stress areas and probable mode of failure. Also the additional design and drafting time of castings as compared to other forms of fabricating.

**Increased Casting Piece Cost.** It is assumed that the piece cost of Class AA, A and B castings is 10 to 20 percent greater than lower level castings because of the additional foundry care necessary to produce castings which will pass the radiographic requirements.

**Radiographic Inspection (X-ray).** The X-ray laboratory's film charge is now approximately $1.50 per sq foot. Individual views are considered to be necessary to indicate such changes in thickness or cross section and direction angle as needed and other film exposures to adequately disclose defects. The average film size necessary for each view can be obtained by multiplying the area of the view taken by two.

**X-ray Inspection Paper Work.** This is the cost of processing the necessary paper work to spot check the films for quality, quantity and selection of standards. It also includes the cost of writing and distributing reports, if necessary, and film storage. This is usually done once for each order of castings in the aircraft field.

**Static Tensile Test Bars.** These test bars are required for each melt of castings or each production lot of castings, whichever is the smaller. The cost involved is that of testing of all bars for ultimate tensile strength, elongation and reduction of area and reports and recording. Magnesium bars are threaded on the ends for secure gripping.

**Processing of a Static Test Casting.** This is the cost concerned with receiving the casting from the X-ray laboratory, its checking by receiving inspection, routing by the process control department, and handling through the shop for machining. It also includes the disposition of the test reports and disposition of the tested casting.

**Machining of Static Test Casting.** This is the cost of laying out dimensions on the casting for machining, the use of improvised tools where necessary, jigs and fixtures, actual machining operations, inspection of dimensions and routing of the part to the test laboratory for the static test. One casting is required for military design and three for airplanes governed by Civil Aeronautic Authority contracts.

**Static Test.** This is the cost of the test rig design and drawings and for material and labor involved in producing the test rig and setting it up for the test. It also includes the cost of performing the static test, writing of reports, their distribution and filing. This is done once for each new design where specified. One casting is required for military design and three for airplanes governed by Civil Aero-

**Table I—Classes of Castings—Excerpts from Mil C-6021 A (ASG)**

CLASS A. Casting, the failure of which will cause loss of aircraft, does not include guided missile and target drone components.

CLASS B. Casting not in Class A and for which the ratio of breaking strength to design ultimate load is 5:1 or less, or for which the margin of safety is not determined. Includes critical parts for guided missiles but not target drones.

CLASS C. Includes casting not covered by Class A or B. Target drone parts need not be included in this class.

CLASS D. All target drone castings.

**Table II—Quality Control Costs for Casting Inspection Classes**

| Operations Definition | CAR | | MILITARY | | | |
|---|---|---|---|---|---|---|
| | AA | Visual | A | B | C | D |
| | 25 to 100 Percent Safety Margin | Insp. 100 percent | Critical for Safety | 5 to 1 or less Allow. Stress | Not in A or B | Not Import. |
| Drafting Time | $20.00 | None | $20.00 | $20.00 | None | None |
| Increased Casting Piece Cost | 10–20 | None | 10–20 | 10–20 | None | None |
| X-Ray Inspection | ** | None | ** | ** | None | None |
| X-Ray Inspection Paper Work | 15.00 | None | 15.00 | 15.00 | None | None |
| Static Tensile Test Bars | Mag. $16.00 Alum. $11.00 | *** | Mag. $16.00 Alum. $11.00 | Mag. $16.00 Alum. $11.00 | Same as B | *** |
| Processing Static Test Casting | 30.00 | None | 30.00 | None | None | None |
| Machining Static Test Casting | $10.00 min. to $500.00 | None | $5.00 min. to $200.00 | None | None | None |
| Static Test | $200 to $1,100, Avge. $650 | None | $150 to $1,000, Avge. $550 | None | None | None |
| Penetrant Inspection or Magnetic Inspection | 0.20 min. | 0.20 min. | 0.20 min. | 0.20 min. | 0.20 min. | 0.20 min. |
| Pressure Testing and Sealing Leaks Includes Testing Fixture | Because of the infrequency of use and the considerable variability, it is recommended that the cost of this operation be estimated for each individual case. | | | | | |

* Static test casting requires five films of each view. Average amount of film is approximately ten times the area of each view.
** Cost is about the same except that class AA requires three static test castings be x-ray inspected. Costs range from 0.10 to $15.00 per part with $3.00 as an average. Class B permits sampling inspection.
*** None if a non-heat treatable material is used.

nautic Authority contracts.

**Fluorescent Penetrant Inspection (Dye Check).** This pertains to nonferrous castings with the exception of anodized aluminum, in which case the anodizing process is used to disclose surface defects. Magnetic inspection is required for ferrous castings.

**Pressure Testing and Sealing of Leaks.** Castings for some designs must be leakproof and therefore require impregnation of porosity with a sealing material under pressure. It is also necessary to inspect for leakage by testing under air or liquid pressure.

An indication of the extent to which these quality control factors can influence a cost analysis is illustrated in Fig. 1. Fig. 2 shows a detail casting drawing for this part. Neglecting quality control, the cost per casting of this housing is $7.85. However, when all quality control costs are included, the true cost per casting increases by approximately 50 percent with the result that casting is even more expensive than machining from solid stock.

Date:
Part Name: SPRING HOUSING
Requirements:
Parts per airplane: 1
Parts per 1st release: 50
Parts per contract: 500

ALL FIGURES ARE ESTIMATES.

Dwg. No. _____
Model _____

Airplanes per lot release 50
Airplanes per contract: 500

Comparable Designs - Cost and Engineering Evaluation

| Cost or Engineering Factors | Design No. 1 Alum. Sand Casting Class "A" Insp. | | Design No. 2 Alum. Bar Stock "Hogout" | | Design No. 3 Riveted Tube Assem. | | Design No. 4 Alum. Impact Forging | |
|---|---|---|---|---|---|---|---|---|
| | Cost | | Cost | | Cost | | Cost | |
| | Total | Unit | Total | Unit | Total | Unit | Total | Unit |
| Raw Material | $ | $ —— | $ 1940. | $ 3.88 | $ 670. | $ 1.34 | $ | $ —— |
| **Machining & Related Operations** | | | | | | | | |
| Labor - Direct and Burden | 1150. | 2.30 | 2030. | 4.06 | 605. | 1.21 | 500. | 1.00 |
| Labor Set-up and Burden | | Included Above | | Included Above | | Included Above | Die Set In Once 20. | .10 |
| Labor - Assembly or Installation and Burden | | —— | | —— | 810. | 1.62 | | —— |
| Outside Tools - Dies, Patterns | 600. | 1.20 | | —— | | —— | 750. | 1.50 |
| Inside Tools - Fabricating | 300. | .60 | 330. | .66 | 450. | .90 | 150. | .30 |
| Purchased Item Cost Casting * (Once per) | 1875. | 3.75 | | —— | | —— | 875. | 1.75 |
| Quality Control (Contract) | 570. | 1.14 | | —— | | —— | | —— |
| ** " " (Once per) (Casting) | 1350. | 2.70 | | —— | | —— | | —— |
| Comparative Total Cost | $ 5845. | $ 11.69 | $ 4300. | $ 8.60 | $ 2535. | $ 5.07 | $ 2325. | $ 4.65 |
| Comparative Differential Cost | $ | $ | $ | $ | $ | $ | $ | $ |
| Weight Saved | | | | | | | | |
| Break Even Point Number of Parts | Most expensive for all quantities | | | | Cheapest for small quantities | | Cheapest for larger quantities | |

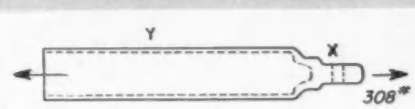
* The cost of quality control per casting would increase rapidly as quantities are reduced.

Remarks:
Conclusion: Design #1 Heaviest and most costly, slow delivery and largest item in quality control.
Design #2 Cheaper, lighter and may be started sooner.
Design #3 Cheaper, light and may be started soon.
Design #4 Cheapest, lightest, strongest, but delivery of parts is slowest.

* Extra drafting time, x-ray insp. for test, processing test casting, machined test casting, static test.
** Increase in casting price, x-ray insp., x-ray insp. paper work, static test bars, anodic insp.

F. A. Monahan — R. H. Lavoon

**Cost analysis sheet (upper right) for aircraft spring housing (below) shows that quality control procedures are the largest single expense item, increasing the casting costs by 50 per cent.**

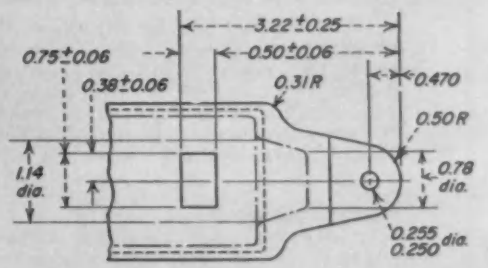



| Stress zone | Margin of safety |
|---|---|
| X | 0 - 50% |
| Y | 50-200% |
| Z | Above 200% |

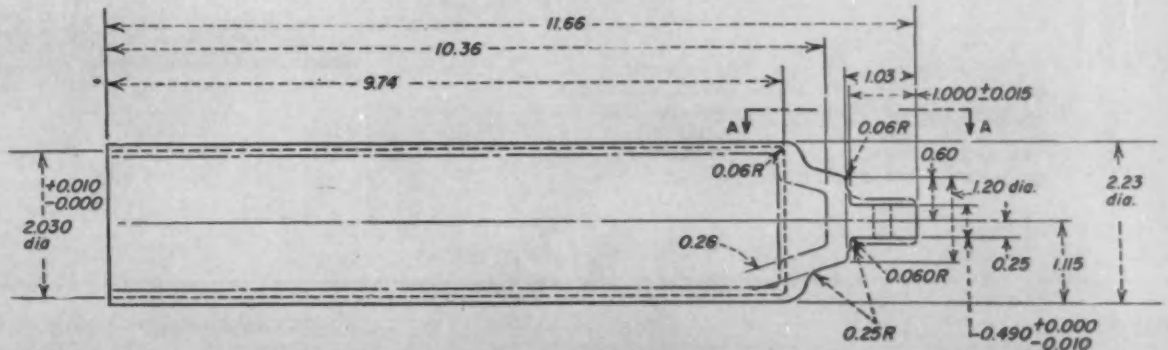
3. *All unmarked areas are in stress zone "Z"*

2. *Probable mode of failure is shear tearout at rivets at front of tube*

1. *Obtain loads from engr. structures group & static test- to destruction*




View AA



# Non-Rubbing Seals for Oil

There are two general types of seals: rubbing and non-rubbing. Rubbing types have positive contact with either rotating or stationary members and are limited to operation and speed because of the friction involved. Non-rubbing seals are not so restricted but require closer

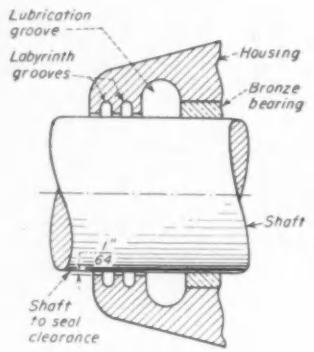


Fig.1

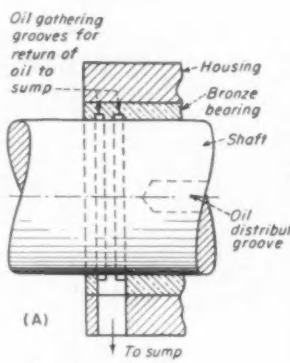


Fig.2

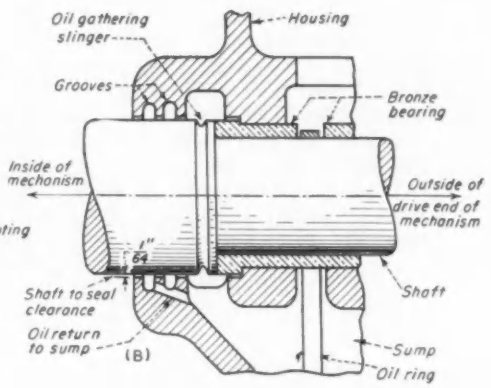



Fig. 1—Non-rubbing seal for grease lubrication. Grooves and housing are filled with grease at assembly or an automatic feed system can be incorporated. Seal offers protection against entrance of foreign matter because of the outward flow of grease through the labyrinth passages. clearance between shaft and seal is about 1/64 inch.

Fig. 2—Non-rubbing seal for oil lubrication. Grooves can be located in bearing, (A), or in housing, (B). Grooves are connected to an oil return passage leading to a sump in housing. This keeps oil loss to a minimum and maintains a constant supply to the bearing. Design does not prevent entrance of foreign material. Radial clearance between shaft and seal is about 1/64 inch.

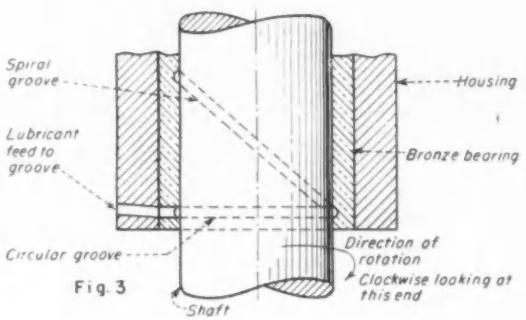


Fig. 3

Fig. 3—Seal for vertical installation. Circular groove picks up lubricant and feeds it to a spiral groove in bearing or shaft. Spiral feeds lubricant to top of bearing. Lubricant runs down between shaft and bearing. This design is only effective when the shaft is rotating.

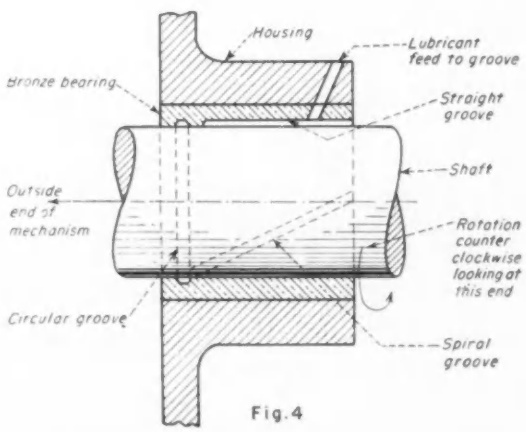


Fig.4

Fig. 4—Similar to Fig. 3 but used for a horizontal installation to reduce leakage of lubricant. Straight groove feeds oil to the bearing. Circular groove collects oil and the spiral groove, located in shaft or bearing, returns it to other end of bearing. Design prevents loss of oil by leakage at outside end of mechanism.

# Retention

DAVID C. SPAULDING, JR.
Product Engineer, The Bunting Bass and Bronze Co., Toledo, Ohio

tolerances and are often more expensive since the shaft, bearing, or housing must be grooved. Distribution over the bearing area is, however, better. Part II of this spread, next month, will discuss rubbing shaft seal construction and application.

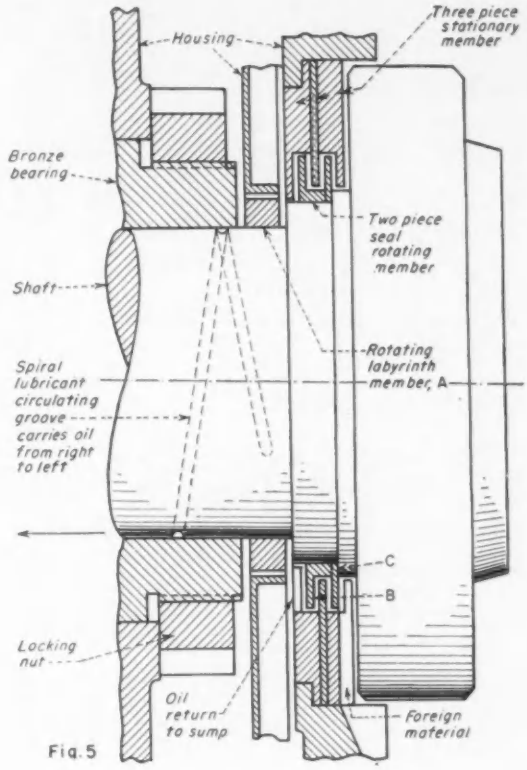


Fig. 5

Fig. 5—Labyrinth seals offer good protection especially at high speeds where the narrow zigzag passage is used in conjunction with centrifugal force. Oil and foreign matter are separated by slinger which limits oil flow past rotating member (A). Inner member (B) throws oil back to sump. Member (C) throws out foreign matter.

Fig. 6—Non-rubbing seal for oil lubrication. Shaft rotation throws lubricant into the inboard groove (B) in the housing and is returned to the oil sump. First slinger (D) throws foreign material out of the assembly. Second slinger (D) feeds foreign material out through groove (A) and hole at (C). Lubricant feeds between shaft and bearing to housing grooves.

Fig. 7—Reservoir type feed for grease lubrication. Grease is distributed in annular groove and feeds through holes in bearing to lubricate the shaft. Foreign matter can be excluded if clean grease is used. Grease will be lost through open bearing ends and assembly must be repacked periodically with new grease.

Fig. 8—Reservoir type feed for oil lubrication. Two bearings are used forming an oil reservoir between them. If porous wall type bearings are used oil will saturate and feed through bearings to the shaft. Outward flow of oil prevents entry of foreign material. Reservoir must be periodically refilled with new oil. Bearings are a press fit in the housing.

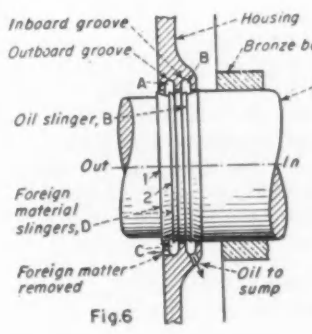


Fig.6

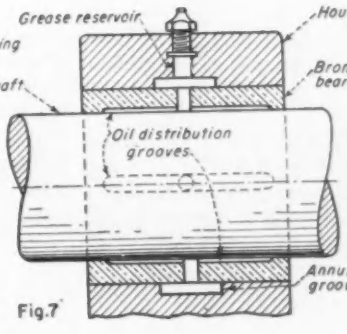


Fig.7

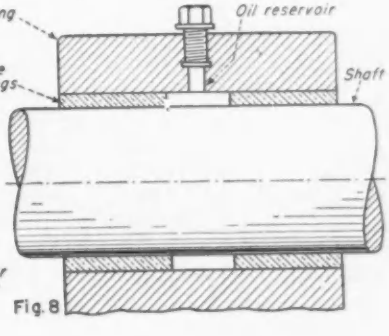
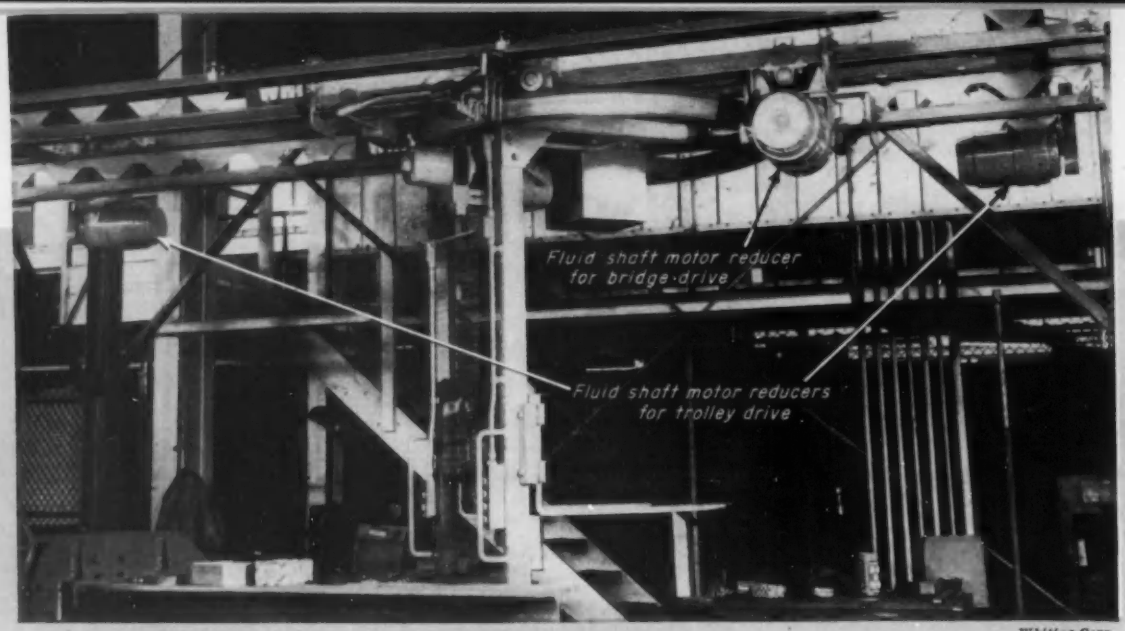


Fig.8




Whiting Corp.

# Fluid Clutches for Electric Drives

*By combining a fluid clutch with a squirrel cage motor . . . .*

*1—High inertia loads can be started with low inrush current,*

*2—Loads can be accelerated without shock, or*

*3—Motor can reach operating speed before load is applied, and*

*4—Space can be saved by using a packaged unit.*

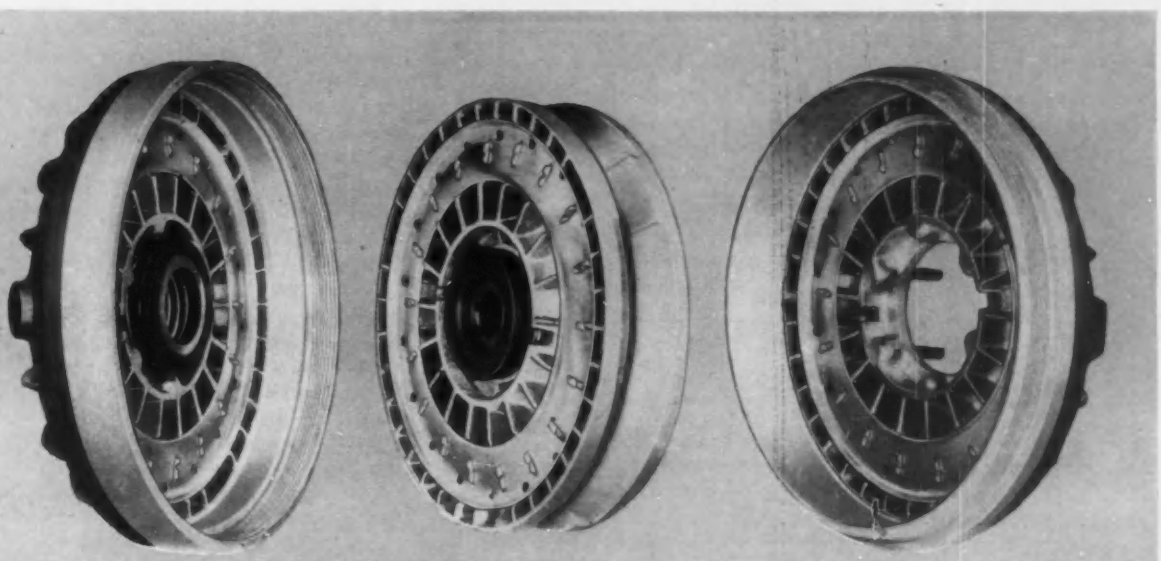
JAMES A. MORRISON
Reuland Electric Company
Alhambra, Calif.

THE FLUID CLUTCH or traction coupling is a two-piece mechanism consisting of an impeller and a runner, Fig. 1, with the entire assembly filled with oil. When the impeller is revolved the oil is thrown to the periphery and strikes the blades of the runner. This exerts a torque on the runner proportional to its weight and the rate at which it is driven by the impeller. To make the unit efficient in either direction of rotation, most commercial designs incorporate straight blades in both the runner and impeller.

The fluid coupling is basically a slip clutch (using the fluid as the driving medium) and does not multiply torque. If a variable speed is needed, a variable drive device must be connected on the output side of the coupling. An electric motor connected to the coupling will accelerate rapidly out of the low speed region of operation where a high starting current is drawn. This substantially reduces the amount of special motor starting equipment. If the coupling is properly selected, the motor speed will rise rapidly to a point—near maximum torque conditions—where coupling of the load takes place. The speed of the load will increase rapidly until it approaches motor speed, and slip decreases to a predetermined minimum.

## Fluid Coupling for Starting and Running

High inertia loads, such as centrifuges, car pullers and chain conveyors, can be readily started with the traction



Twin Disc Clutch Co.

Fig. 1—Typical traction coupling showing impeller and runner. Note straight blades permitting rotation in either direction.

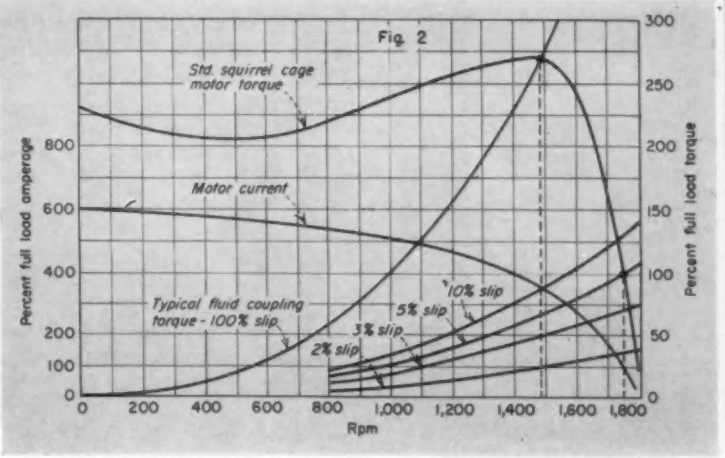



Fig. 2—Typical squirrel cage motor torque and current curves. One hundred percent slip of coupling should occur at maximum motor torque. Full load torque, for example coupling, is 5 percent.

coupling and a standard squirrel cage motor. Since the coupling allows the motor to accelerate freely until it reaches maximum torque, the full advantage of any specified motor rating can be obtained, Fig. 2. Then too, the motor current has been greatly reduced from its locked rotor peak and can accelerate the load without overheating. On high intertia drives this frequently permits a reduction of as much as $\frac{1}{3}$ in motor output horsepower over conventional designs, where motor rating must be increased to provide sufficient thermal capacity.

When applying a coupling to a power source, the size of the unit is normally selected to give from 3 to 5 percent slip at full running load and speed. However, a compromise in the normal method of selecti .n may be necessary to match the drag torque of the coupling with the torque curve of the prime mover. To make available the maximum motor torque for starting and accelerating the load, it is desirable to have the drag torque curve of the fluid unit intersect the prime mover torque curve at its peak output. This is especially true of standard squirrel cage electric motors where 200 to 300 per cent of full load torque can be made available for accelerating purposes. So that the drag torque curve will be properly matched with the peak prime mover torque curve, it may be necessary to use either a smaller coupling or one with a smaller fluid capacity, thereby forcing operation at a higher rate of slip at full torque.

In selecting a coupling for high inertia loads under frequent starting conditions special attention must be paid to the heat dissipation capacity of the coupling. Small couplings have

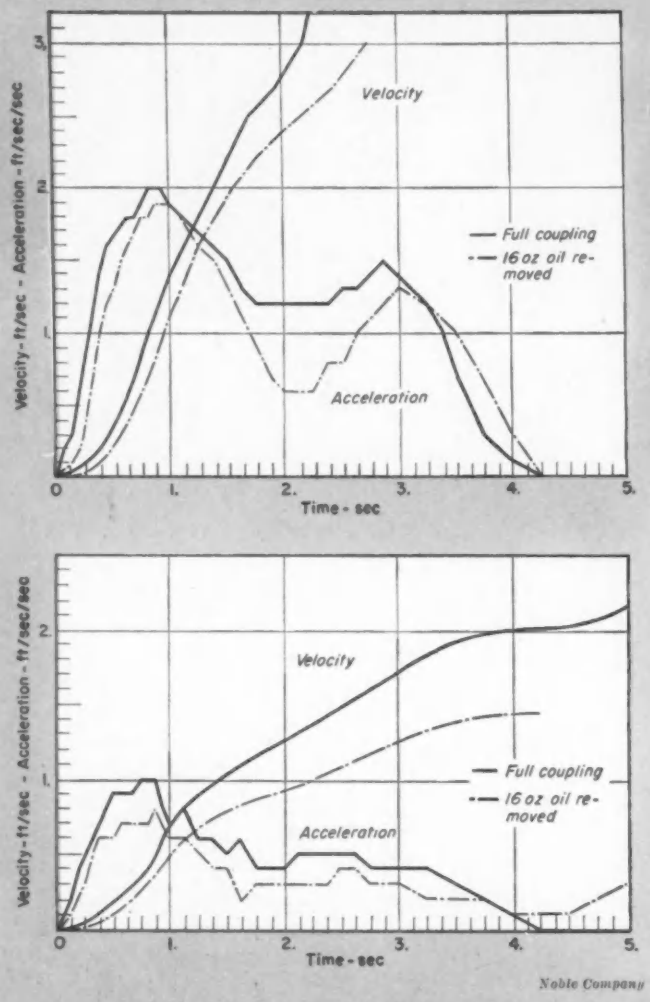



**Fig. 3—Curves showing the effect of fluid removal on the velocity and acceleration of a 5-ton crane at 1,800 rpm and 900 rpm.**

better cooling characteristics than the larger ones. The reason: small increment increases in coupling diameter result in large increases in torque and horsepower capacity, while the cooling area is not similarly multiplied. (See *Product Engineering,* March 1950).

When the fluid coupling is used, its cost is offset not only by the reduction in motor size but also by further economies in wiring, control apparatus and power transmission equipment. If the load must be started frequently, the input reduction during the acceleration period is substantial and major power savings can be achieved. To point up the savings that can be made in transmission equipment in a car puller drive using a conventional squirrel cage motor, shock requirements alone call for the application of AGMA Class III gears. But with the fluid coupling which eliminates shock, Class I gears can be used.

Problems arising from the use of tandem or multiple drives have been solved with the fluid coupling. On a multiple drive each coupling unit seeks its own speed to deliver the power needed at the point of application. This characteristic has been used effectively on overhead chain conveyor systems. Often, moving the chain and suspended load calls for torque that would strain the chain if applied at any one point. By installing driving units equipped with fluid couplings at various points along the chain, minimum-size chains, supports and other hardware can be used.

## Acceleration Characteristics of Fluid Couplings

General characteristics of the traction coupling indicate its prime application: as an acceleration device where smooth acceleration is a major factor as in crane drives and conveyors handling fragile materials.

The traction coupling can provide any degree of softness in acceleration by changing the oil level which is readily adjusted after installation on the driven machine.

The effect of fluid removal on acceleration is shown in Fig. 3 on the operating characteristics of a two-speed motor drive. The slow speed is useful for spotting; the high speed for long runs. A crane of 5-ton capacity with an 1,800/900 rpm motor had a top speed of 300 ft per min. The removal of one pint of fluid reduced the rate of acceleration and at the lower speed also had a marked effect upon the velocity.

While most of the fluid drives have been used either on bridge or trolley motions, some experimental work is being done with hoisting motors. Tests indicate that a hoist with a two-speed fluid drive would have operating features comparing favorably with wound-rotor drives. The fluid drive would have lower initial cost, and maintenance would be less. Other advantages such as the reduction of the impact load on the hoist support and the removal of shock loading on the gears of the hoisting mechanism would favor the fluid drive over the wound rotor motor.

## Deceleration When Using a Fluid Coupling

On floor-operated cranes the deceleration is generally accomplished with a solenoid-operated, spring-set brake. A brake of this type puts a fixed retarding action on the load whether it is going fast or slow and regardless of load. After the crane

has been stopped, this brake holds the bridge locked in position. Brake action must be adjusted for average conditions, which results in poor operation at either extremes of loading or speed.

When a fluid motor drive is used, a brake can be applied on the motor side of the coupling. This will allow for a smooth deceleration, but it will not lock the output shaft, since there is no solid connection through the coupling. However, two brakes and the fluid coupling will give the desired combination of smooth deceleration and a final locked output shaft. Fig. 4 shows a complete package unit consisting of a motor, coupling and two brakes. To obtain the desired operating results, the brake on the motor side of the coupling is applied as soon as the motor winding is de-energized; the other brake is applied 1 to 2 sec later through an adjustable time delay device in the packaged unit.

A similar package to that depicted in Fig. 4 has been applied to a rather unusual drive. The runways of a crane were on a 4 percent slope. Use of a conventional solenoid brake would result in an abrupt stop on the uphill travel and make the load dangerous to handle. A light drag brake would permit the crane to drift before stopping. A package unit having a drag brake and a time delayed solenoid brake gave excellent results in both uphill and downhill travel.

## COMPARISON OF CLUTCH TYPES

**Primarily, in motor applications, the fluid coupling permits a rapid build-up of motor speed without the inherently high current values usually associated with motor starting when mechanical clutches are used. Also, fluid clutches will slip to provide for overload protection which the electric units will not do.**

**Another advantage is that the fluid unit does not require additional control equipment. Mechanical clutches need levers and linkages; hydraulic or pneumatic units require valves, cylinders and lines; electric clutches require rheostats, converters and wiring. The fluid coupling is completely self contained.**

**Slippage, on many applications, is of prime importance especially where the possibility of a machine jamming can cause extensive damage to the motor, machine and shafting. Although a mechanical slip clutch can be used, the fluid clutch offers economy of installation and maintenance since slippage of mechanical units tend to wear out clutch facing. This necessitates periodic inspection tear downs that cut into production time.**

## Mechanical Arrangement of Coupling and Motor

Once the fluid coupling has been selected as the most practical drive for any particular job, the question of the best mechanical arrangement must be solved. Since the coupling torque is developed by the impingement of the fluid mass on the runners, the coupling must be mounted on the high speed input shaft to the driven machine. Horsepower capacity curves, Fig. 5, show the large effect of input rpm on the traction coupling. A reduction in input speed, say from 1,800 rpm to 1,600 rpm when using a 9.5 HC coupling and 4 percent slip, reduces the horsepower from 10 to about

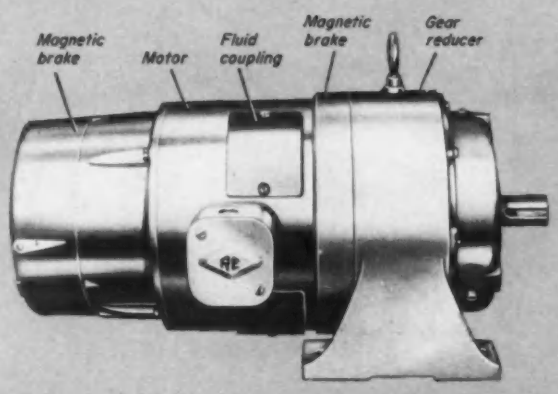



Fig. 4—Package unit consisting of a fluid coupling, electric motor, two solenoid brakes and gear reduction.

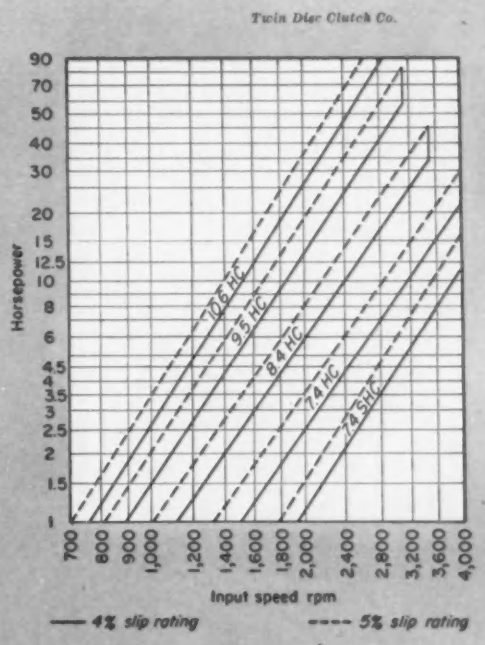



Fig. 5—Horsepower capacity curves indicating a selection of couplings of various diameters at 4 and 5 percent slip values.

6.75 or 32.5 per cent. This requirement usually places the coupling in a position that directly connects it to the 1,800 rpm motor.

Since the coupling is an oil-filled device and must have a seal on the high speed output shaft, the initial accuracy of alignment and the maintenance are important in securing adequate seal life. The integrally mounted unit, Fig. 6, benefits from both short bearing centers and the obvious advantages of machining in a round frame. The standard motor and separate coupling can also have this necessary rigid support if floor-mounted bearing supports and a solid base plate are used. Such an arrangement requires accurate machining and doweling and, of course, is not as compact.

In those instances where a quantity is relatively large and space is not critical, a fabricator could supply a satisfactory arrangement of the components on an economical basis. However, the package unit of motor and coupling, which is now being produced by four or five manufacturers, fills the demand for a unit that can be assembled to any machine as readily as a standard electric motor. The availability of these units with gear trains, brakes and other accessories simplifies the application of fluid drives, both in design and assembly.

Package units from ½ to 25 hp are available with various enclosures, including drip proof and totally enclosed fan cooled. The units can generally be mounted in any position desired. In fact, one manufacturer offers a unit with flange and face end brackets for vertical and horizontal mounting.

## NEMA Standards for Package Units

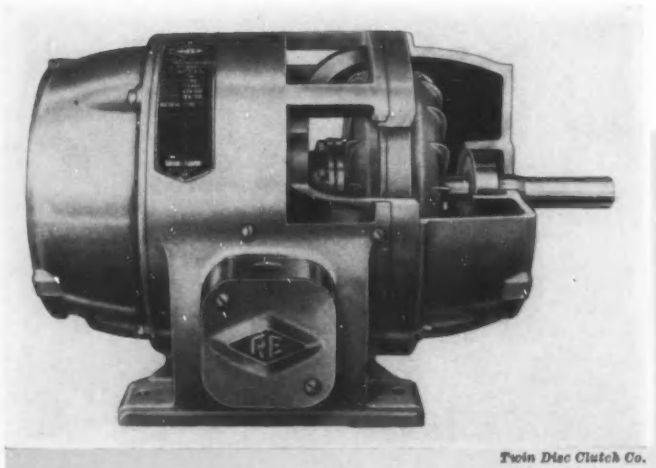
Some attempt has been made to standardize the fluid units into NEMA mounting dimensions exactly like the motor dimensions of a comparable rating. In most instances this would not have any great value, as the fluid unit, by virtue of its special characteristics, could rarely be replaced by a standard off-the-shelf motor. As it is most unlikely that fluid couplings can be reduced from their present size, the advent of new NEMA dimensions scheduled for the next few years, will probably make any standardization to NEMA motor mounting virtually impossible. (See *Annual Handbook of Product Design for* 1954 and *Product Engineering,* Dec 1953, for new NEMA standards).

The manufacturers of the package units have generally followed one of two design approaches. Either design a housing for the coupling and mount a flange type motor behind it, Fig. 7, or incorporate the coupling into the motor frame, Fig. 6. The second approach has proved the more economical and generally allows a more compact unit. It also makes available a full line of end brackets—including NEMA flange types—without further development. However, it does not readily lend itself to some special enclosures, such as explosion proof.

The motor frame construction also requires special electrical designs, since the stator laminations must be of a larger diameter than the coupling. The new NEMA standards will further reduce the diameters of the laminations, thereby forcing a special design on any manufacturer who incorporates the fluid coupling within the motor frame. These smaller diameters will also complicate the use of the separate coupling with the new motor size, as clearance will have to be provided in the bed plate for some motor sizes.

## Conclusion

New uses are being found for the fluid coupling drive; particularly in transmission systems where shock or high inertia loads are present. Long term savings are obtained in transmission and equipment replacement costs by reducing starting and running shocks. Such savings are usually difficult to measure, but the initial higher investment for the fluid unit is often more than justified.



*Twin Disc Clutch Co.*

**Fig. 6—Package unit consisting of motor and coupling. Note short bearing centers supporting coupling.**

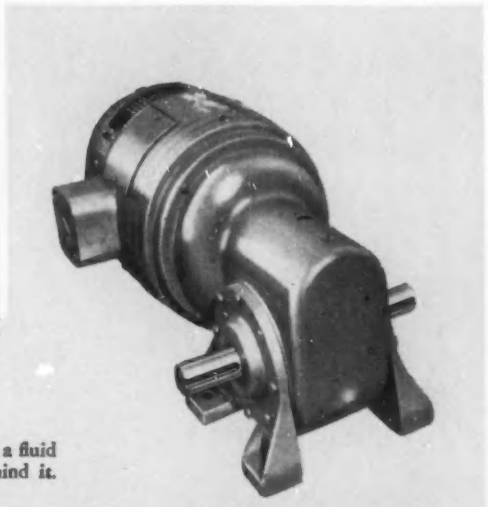


**Fig. 7—Right angle motoreducer and housing for a fluid coupling with a flange type motor mounted behind it.**

# Resonance Amplitudes

## *In Systems With a Single Degree of Freedom*

**Nonlinear differential equations offer an accurate method of analysis for complex vibrating systems found in rotating and oscillating machine parts, vibration isolation and noise studies. A variety of mechanical and electrical devices and systems subject to nonlinear effects were discussed in *'Product Engineering'*, May 1954, pp 181-192. This article treats one specific problem of this type—resonance amplitude in vibrating systems with a single degree of freedom. Following a brief review of linear theory, a solution is derived for a general nonlinear system considering nonlinearity in both restoring and damping forces.**

**H. NORMAN ABRAMSON**
Assoc. Prof. of Aeronautical Engineering
The Agricultural and Mechanical
College of Texas

A SIMPLE VIBRATING SYSTEM excited by some external disturbance undergoes oscillations whose magnitude depend on the frequency of the exciting force. As the exciting frequency approaches the natural frequency of the system, the amplitude of the oscillations increases to a maximum value—this phenomenon being called resonance. The possibility of encountering resonance is one of the principal reasons why the study of vibrations is important. Engineering structures are often subjected to external disturbances, for example, through a slight unbalance in rotating machinery, with the resultant danger that the structure may fail because of the building up of vibrations of large amplitude; therefore, a knowledge of the maximum amplitudes of vibration which might be encountered is of importance to designers of most types of equipment.

Systems described by linear differential equations have been studied thoroughly and much is known regarding their behavior (Ref. 1). In industry, however, the engineer is rarely confronted with such idealized problems. Rather, it has been found necessary in recent years to devote much effort toward gaining some insight into the behavior of systems described by nonlinear differential equations. Generally, the latter can be solved only by approximate methods.

In this discussion, the resonance amplitudes in a single degree of freedom system are considered. After a brief review of linear theory, a general nonlinear system is studied.

### Linear System

Consider a single degree of freedom system acted upon by a periodic disturbing force and described by the linear differential equation:

$$a\frac{d^2x}{dt^2} + b\frac{dx}{dt} + cx = P_o \cos \Omega t \quad (1)$$

in which $a$, $b$, $c$ are positive constants, $x$ is the displacement measured from the position of static equilibrium, and $P_o$ and $\Omega$ are the amplitude and frequency, respectively, of the disturbing force. With the notation:

$$\left.\begin{aligned} &\frac{P_o}{a} = p,\ \frac{b}{2\sqrt{ac}} = D,\ \Omega t = \tau,\ \frac{\Omega}{\omega} = \eta \\ &\sqrt{c/a} = \omega = \text{undamped natural frequency} \\ &\frac{P_o}{c} = s = \text{static deflection} \end{aligned}\right\} \quad (2)$$

Eq (1) becomes:

$$\frac{d^2x}{d\tau^2} + 2D\omega\frac{dx}{d\tau} + \omega^2 x = p\cos\tau \quad (3)$$

This is a second order nonhomogenous linear differential equation, a particular solution of which is:

$$x_p = X\cos(\tau - \epsilon) \quad (4)$$

where $X$ is the amplitude and $\epsilon$ is a phase angle. This solution leads di-

rectly to the equation:

$$X = \frac{s}{\sqrt{(1-\eta^2)^2 + 4D^2\eta^2}} \qquad (5)$$

which represents a family of response curves, with the damping $D$ as a parameter, when plotted with $\left|\frac{X}{s}\right|$ and $\eta^2$ as coordinates. As shown in Fig. 1, resonance occurs where $\eta^2 = 1$.

The maximum amplitudes are readily described by the locus of horizontal tangents shown as a light broken line in Fig. 1. Thus, the condition $\frac{\partial X}{\partial \eta^2} = 0$, when applied to Eq (5), yields

$$\eta^2 = 1 - D^2 \qquad (6)$$

From this:

$$X_{max} = \frac{s}{2D\sqrt{1-D^2}} \qquad (7)$$

It is to be noted that the locus of $X_{max}$ lies at values of $\eta^2$ which are slightly less than unity, that is, slightly below resonance. For all but very large values of the damping, it is a fair approximation to assume that the maximum (or resonance) amplitude occurs exactly at $\eta^2 = 1$. Then, from Eq (5):

$$X_r = \frac{s}{2D} \qquad (8)$$

Using Eq (2) and noting that Eq (8) is valid for $\omega = \Omega$, the latter can be written as follows:

$$X_r = \frac{P_o}{b} \qquad (9)$$

The vertical bold line, $\eta^2 = 1$, in Fig. 1, represents free undamped vibration. Eq (9) applies to the intersection of the response curve with that for free undamped vibration.

Before considering nonlinear systems, the variation of phase angle $\varepsilon$ with $\eta^2$, shown in Fig. 2, should be noted. At resonance, $\varepsilon = \frac{\pi}{2}$.

## General Nonlinear System

A system will now be considered whose restoring force is described by a function $f(x)$ and whose damping force is described by a function $g\left(\frac{dx}{dt}\right)$. The nonlinear differential equation that governs the motion, under the action of a periodic disturbing force, is:

$$E \equiv a\frac{d^2x}{dt^2} + b\,g\left(\frac{dx}{dt}\right) + c\,f(x) - P_o\cos\Omega t = 0 \qquad (10)$$

There are many approximate methods for obtaining solutions of equations such as Eq (10); however, one of these, the Ritz Method, (Ref. 2) leads to a particularly useful set of relations. The method assumes that the differential equation $E(x,t) = 0$ is known and that its solution can be represented by a series of the form:

$$x = A_1\psi_1(t) + A_2\psi_2(t) + \ldots A_n\psi_n(t)$$

where $\psi_1(t) \ldots \psi_n(t)$ are known functions and $A_1 \ldots A_n$ are undetermined coefficients. Then $n$ nonlinear algebraic equations for the $n$ coefficients result from the evaluation of the integrals:

$$\int_{t_1}^{t_2} E(x,t)\,\psi_1(t)\,dt = 0,$$

$$\int_{t_1}^{t_2} E(x,t)\,\psi_2(t)\,dt = 0 \ldots$$

$$\int_{t_1}^{t_2} E(x,t)\,\psi_n(t)\,dt = 0$$

While the Ritz method may be derived from the calculus of variations, using the idea that the minimization of a certain integral and the solution of the Euler differential equation are identical problems, the method can also be regarded as an averaging process. From this point of view, it would be necessary to integrate over the period, the product of the differential equation and some "weight function." According to the Ritz method, the weight function should be taken as that used in the assumed form of solution. In many cases, it will be quite sufficient to take only the first term of the assumed series to represent the solution. Therefore, the solution of Eq (10) is assumed as follows:

$$x = X\cos(\tau - \epsilon), \qquad \Omega t = \tau \qquad (11)$$

or,

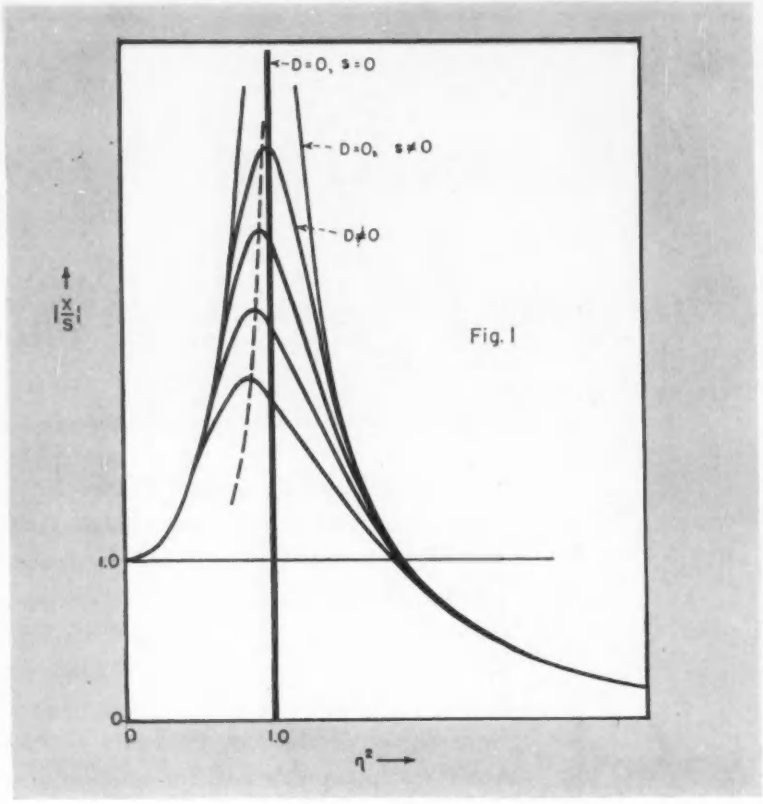
$$x = X_1\cos\tau + X_2\sin\tau \qquad (12)$$

where

$$X_1 = X\cos\epsilon$$
$$X_2 = X\sin\epsilon \qquad (13)$$

Using Eqs (10) and (12), these two integrals must be evaluated:

$$\left.\begin{aligned}\int_0^{2\pi}\Big[(-a\Omega^2X_1 - P_o)\cos\tau - a\Omega^2X_2\sin\tau + b\,g\left(\frac{dx}{dt}\right) + cf(x)\Big]\cos\tau\,d\tau = 0\\ \int_0^{2\pi}\Big[(-a\Omega^2X_1 - P_o)\cos\tau - a\Omega^2X_2\sin\tau + b\,g\left(\frac{dx}{dt}\right) + cf(x)\Big]\sin\tau\,d\tau = 0\end{aligned}\right\} \qquad (14)$$



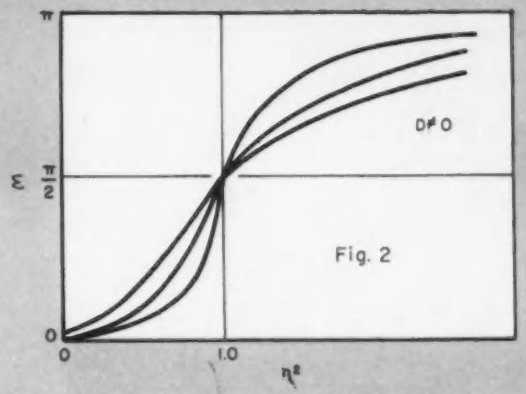



Fig. 2

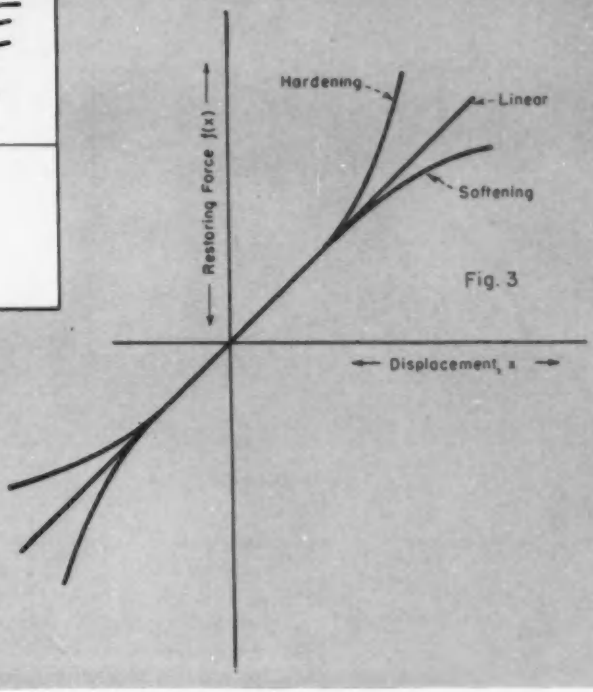



Fig. 3

Fig. 1—Amplitude vs frequency ratio.

Fig. 2—Phase angle vs frequency ratio.

Fig. 3—Illustrations of linear damping with hardening and softening restoring force.

The evaluation of these integrals leads to the two algebraic equations:

$$\left.\begin{aligned} -a\Omega^2 X_1 + b\,C'(x) + c\,C_1(x) - P_o = 0 \\ -a\Omega^2 X_2 + b\,S'(x) + c\,S_1(x) = 0 \end{aligned}\right\} \quad (15)$$

where

$$\left.\begin{aligned} C_1(x) &= \frac{1}{\pi}\int_0^{2\pi} f(x)\cos\tau\,d\tau, \\ S_1(x) &= \frac{1}{\pi}\int_0^{2\pi} f(x)\sin\tau\,d\tau \\ C'(x) &= \frac{2}{\pi}\int_{\tau_1}^{\tau_1+\pi} g\left(\frac{dx}{dt}\right)\cos\tau\,d\tau, \\ S'(x) &= \frac{2}{\pi}\int_{\tau_1}^{\tau_1+\pi} g\left(\frac{dx}{dt}\right)\sin\tau\,d\tau \end{aligned}\right\} \quad (16)$$

and $\tau_1$ indicates the time at which the velocity is zero. The evaluation of these integrals for special cases will be given later.

The Eqs (15) describe the response curves in terms of the components $X_1$ and $X_2$. From these, it is theoretically, possible to evaluate the maximum value of the amplitude of motion by determining the locus of horizontal tangents as was done in the linear case; however, this procedure is very difficult, algebraically. Thus, the approximation indicated in the linear system will be used. The points where the response curves intersect the curve of free undamped vibration then define the resonance amplitudes.

The equations which describe the curve of free undamped vibration are obtained readily from Eqs (15) by letting both $P_o$ and $b$ approach zero:

$$\left.\begin{aligned} -a\Omega^2 X_1 + c\,C_1(x) = 0 \\ -a\Omega^2 X_2 + c\,S_1(x) = 0 \end{aligned}\right\} \quad (17)$$

The intersection points are now determined by simultaneous solution of Eqs (15) and (17), which yields the two relations:

$$S'(x) = 0, \qquad C'(x) = \frac{P_o}{b} \quad (18)$$

The first of these equations determines the phase angle $\varepsilon$ at the resonance amplitude, and the second defines a new curve which will, in turn, determine the resonance amplitude.

Considering the first of Eqs (18), regardless of the functional form of the damping force, the phase angle will always have the value $\pi/2$ at the resonance amplitude. Defining $\tau - \varepsilon = \sigma$, it is possible to write the following equation:

$$\int_{\tau_1}^{\tau_1+\pi} g(-\Omega X\sin\sigma)\sin(\sigma+\epsilon)\,d\sigma = 0$$

This can then be expanded to the form:

$$\cos\epsilon\int_{\tau_1}^{\tau_1+\pi} g(-\Omega X\sin\sigma)\sin\sigma\,d\sigma = 0$$

The integral does not vanish. Therefore, $\cos\varepsilon = 0$, or $\varepsilon = \pi/2$.

The evaluation of the second of Eqs (18) will depend upon the particular form of the damping force.

Three examples will now be used to demonstrate the significance and application of these results.

## Linear Damping

For linear damping, the system is considered to be such that:

$$g\left(\frac{dx}{dt}\right) = \frac{dx}{dt}$$

The restoring force $cf(x)$ may be either hardening or softening as shown in Fig. 3. In either case, Eqs (18)

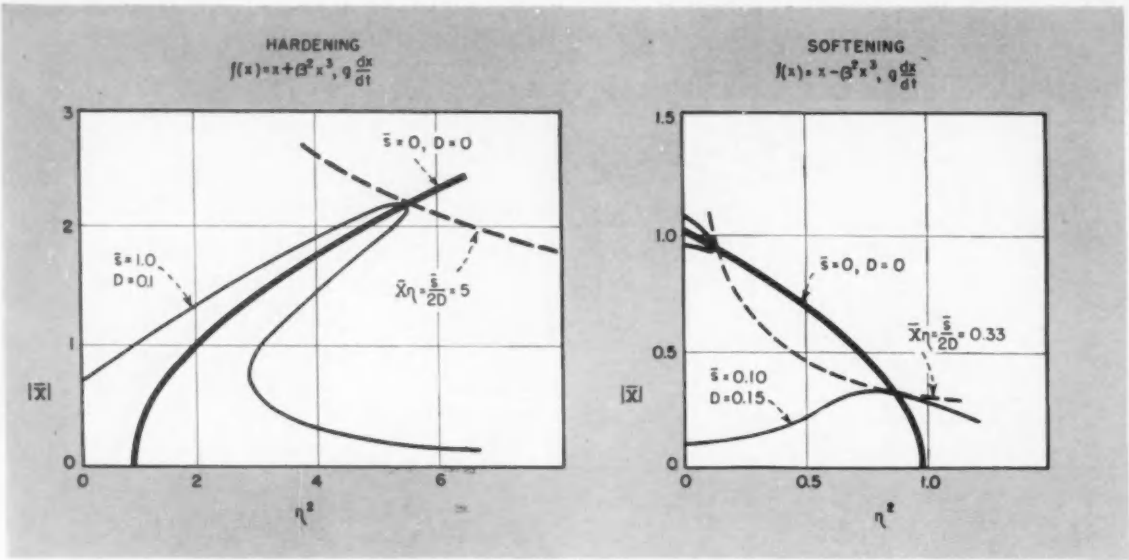



Fig. 4—Response curves for linear damping.

yield $\varepsilon = \pi/2$ from the first, and from the second:

$$C'(x) = \frac{2}{\pi}\int_{\tau_1}^{\tau_1+\pi} (-\Omega X_1 \sin\tau\cos\tau + \Omega X_2 \sin^2\tau)\, d\tau = \frac{P_o}{b}$$

or

$$\Omega X_2 = \frac{P_o}{b}$$

Thus, since $\varepsilon = \pi/2$:

$$\Omega X = \frac{P_o}{b} \qquad (19)$$

Using Eqs (2), this may be rewritten as

$$\eta X = \frac{s}{2D} \qquad (20)$$

As $\eta^2$ approaches unity, this equation reduces to the result found for the linear case, Eq (8). This result does not depend upon the particular form of the restoring force that is acting.

Eq (20) describes a hyperbola in the response diagram, asymptotic to the coordinate axis, with $\frac{s}{2D}$ as a parameter; the intersection of this hyperbola with the curve for free undamped vibration yields the resonance amplitude; therefore, the curve described by Eq (20) is the locus of resonance amplitudes. For systems with a hardening restoring force, one intersection point will be found; however, for systems with a softening restoring force, two intersection points may occur. Since systems with softening restoring forces have two positions of static equilibrium, and oscillations may occur about either of these positions, the physical meaning of the second intersection point is clear.

Response curves for the hardening and softening cases just described, are shown in Fig. 4, together with the corresponding hyperbolas. In these figures,

$$f(x) = x \pm \beta^2 x^3$$

where $\beta^2$ is a positive constant and the positive sign corresponds to the hardening case. For ease of computation the following notation has been adopted:

$$\bar{X} = \beta\sqrt{3/4}\, X, \qquad \bar{s} = \beta\sqrt{3/4}\, s$$

## Nonlinear Damping

It was already shown that the phase angle has the value $\varepsilon = \pi/2$, regardless of the form of the damping function. The integral $C'(x)$ however, has a different value for each damping function. As a specific example of nonlinear damping, consider the case of square velocity damping. Here:

$$b\,g\left(\frac{dx}{dt}\right) = b\frac{dx}{dt}\left|\frac{dx}{dt}\right|$$

where $\gamma$ is a positive constant. Then

$$C'(x) = \frac{8}{3\pi} X^2\Omega^2$$

and the hyperbola equation becomes

$$X^2\Omega^2 = \frac{3\pi}{8}\frac{P_o}{b} \quad \text{or}$$

$$X^2\eta^2 = \frac{3\pi}{8}\left(\frac{s}{2D}\right)\frac{1}{\omega}$$

Solutions for other types of damping functions are obtained similarly.

## Conclusions

Since the resonance amplitude is determined by the intersection of the proper hyperbola and the curve of free undamped vibration, the general relationships, Eqs. 15, need not be solved. Instead, it is only necessary to solve the simpler formulas, Eqs (18), and evaluate the integral $C'(x)$, which depends upon damping force but not restoring force. For linear damping, plotting the two curves defined by Eqs (17) and (20) is all that is required.

Also, since the effect of damping is negligible except in the vicinity of resonance, the complete damped response curve can be constructed on the basis of zero damping—which simplifies computation—and the resonant amplitude as described previously.

### REFERENCES

1. Timoshenko, S. P., "Vibration Problems in Engineering," 2nd Ed., D. Van Nostrand Co., New York, 1938.

2. Klotter, K., "Nonlinear Vibration Problems Treated by the Averaging Method of W. Ritz," Tech. Rept., No. 17, Part I (N6—onr—2), Stanford University, May 1951.

J. H. KEELER
General Electric Research Laboratory, The Knolls, Schenectady, N. Y.

**When corrosion-resistant, low-neutron-absorbing zirconium is considered in the light of its strength and ductility, the influence of grain structure, purity and temperature must be known. Reactions to cold working and heat treatment are also vital factors.**

AS IS TRUE OF ANY METAL, the strength of zirionium is not only influenced by metallurgical variables but also by environment, state of stress and conditions under which stress is applied. Variables usually considered in the study of strength are grain size and orientation, amount of strain in the metal, structure as influenced by prior heat treatment, and impurities or alloying elements. In view of the complexity of the subject, this last aspect as well as the influence of environment and stress state, will be discussed only briefly. The main emphasis will be placed on the first set of variables mentioned above because they are factors that should be kept in mind when unalloyed zirconium is used in applications where strength and ductility are important. Table I lists room temperature mechanical properties.

INFLUENCE OF GRAIN SIZE. Recrystallization during annealing of cold-worked zirconium is a process that can be controlled by the time or tempera-

## HIGH CORROSION RESISTANCE COMMERCIAL VALUE OF ZIRCONIUM

**One of the newer metals of growing significance, zirconium is generally associated with titanium. However, it is different from titanium in a way similar to that in which the many stainless steels differ from each other. Titanium and zirconium are produced from the ores by similar processes. Both are highly reactive at elevated temperature and exhibit high corrosion resistance in the range from room temperature to 100 C. The more outstanding differences between the two metals are their densities, elastic moduli, absorption of thermal neutrons, and corrosion resistance in certain specific circumstances. With about 50 percent higher density, zirconium will not compete with titanium for aircraft or other applications where weight is the deciding factor. Coupled with the lower density, titanium has a larger elastic modulus, again an advantage in structural applications. Zirconium has a much lower absorption of thermal neutrons and so for certain nuclear applications, zirconium has considerable advantage. This accounts for the AEC's interest in the development and understanding of zirconium and zirconium-base alloys, while the commercial interests in zirconium stem from its outstanding corrosion resistance.**

ture of the treatment. Although ductility can be varied according to recrystallization treatment, it is strength that is significantly altered. Both increased time of treatment at a given temperature and increased temperature with a constant time produce weak material. Since a shorter time at a higher temperature gives the same results as a longer time at a lower temperature, it is preferable to specify the grain size rather than the treatment to achieve desired properties. The curves in Fig. 1 show that finer-grained zirconium exhibits higher strength at and slightly above room temperature than does larger-grained material.

High-purity zirconium recrystallizes at temperatures above 400 C. One hour at 500 C is sufficient to produce fine-grained high-strength material, while a half hour at 600 to 800 C results in larger-grained, but weaker material. The importance of time and temperature is illustrated by the fact that a 48-hr anneal at 500 C produces larger grains and thus a weaker material than does a half hour treatment at 800 Centigrade.

If the amount of cold reduction prior to annealing is varied widely enough, it can influence the grain size after annealing. Usually this is not considered a critical factor because zirconium sheet cold reduced between 30 and 90 percent and then annealed in a similar manner exhibits identical grain sizes.

INFLUENCE OF PURITY. Recent progress in the mass production of ductile zirconium by the iodide and chloride processes has seen a significant decrease in the amount of impurities. It is entirely possible that the properties of the more-expensive, higher-purity iodide process zirconium may soon be matched by the product of the chloride process which is being perfected by the U. S. Bureau of Mines. The influence of impurities therefore merit attention since the properties of commercially produced zirconium are continually changing. Table II gives data on the purity of zirconium produced by the two processes.

Zirconium is extremely reactive at elevated temperatures and in the molten condition attacks most refractories. For this reason, it is melted either in graphite crucibles where up to 0.3 percent carbon is picked up, or in water-cooled copper crucibles which remain too cold to permit appreciable solution by the liquid metal. The metal also reacts with all but the inert gases at temperatures above 300 C. For example, absorption of oxygen has occurred at 200 C, nitrogen as low as 500 C[3] and hydrogen at room temperature. Surface layers of other gases such as water vapor can greatly diminish or prevent the pick-up of hydrogen at room temperature. The reaction of zirconium with gases at temperatures less than 300 C is sufficiently slow or easily stopped by absorbed layers so that this contamination is not generally significant.

Unlike oxygen and nitrogen, hydrogen can be removed from zirconium by heating the metal in a vacuum at temperatures above 800 C. Since zirconium is so reactive, and oxygen and nitrogen cannot be removed, precautions must be taken during hot working and heat treatment to prevent the metal from picking up contaminants in quantities sufficient to alter desired properties. If the piece of zirconium being handled is sufficiently large and the surface layer is ultimately to be removed, zirconium can be heated in air (massive sections have been successfully worked at 800 C). Thin sections or sheets, because of the large surface-to-volume ratio, are affected detrimentally and so should not be exposed to air at elevated temperature.

Oxygen and nitrogen in zirconium raise its harness and strength at room temperature and, in sufficient quantity,

**Table I—Room Temperature Mechanical Properties of High-Purity Zirconium**

| Property | Iodide Process | Chloride Process |
|---|---|---|
| **Severely Cold-Reduced** | | |
| Ult Ten Strength, psi | 83,600 | 90,000 |
| 0.2% Offset Yield Strength, psi | 72,000 | 84,000 |
| Elongation in 2.25 in., percent | 1—18 | 10 |
| Reduction in Area, percent | 8—60 | — |
| Hardness | $R_A$55 | $R_B$98 |
| **Annealed** | | |
| Ult Ten Strength, psi | 24,000–43,000 | 42,000–62,000 |
| 0.2% Offset Yield Strength, psi | 10,700–26,000 | 29,000–38,000 |
| Elongation in 2.25 in., percent | 24–54 | 30 |
| Reduction in Area, percent | 25–75 | — |
| Hardness | $R_B$35–52<br>$R_A$20–35 | $R_B$83–91 |
| Elastic Modulus, x $10^6$ | 9–14 | 12–14 |
| Charpy Impact Strength, ft-lb | 2.5–75 | 14–16 |

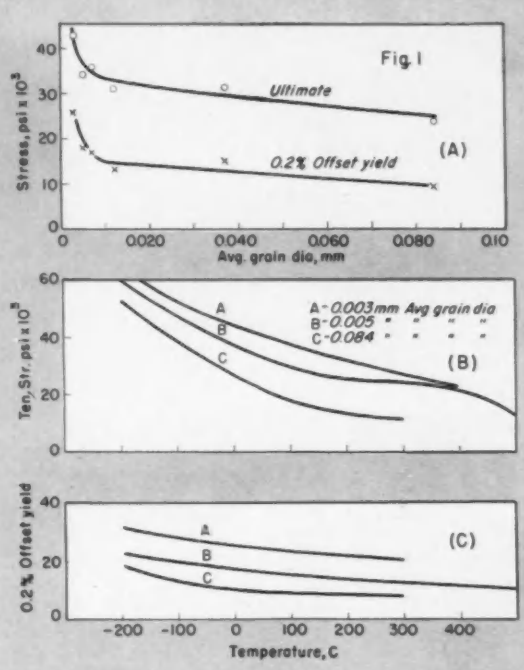



Fig. 1—Relation between strength and grain size (A) in rolled and annealed crystal bar zirconium at room temperature; tensile strength (B) and yield strength (C) versus temperature showing influence of grain size.

Fig. 2—Influence of oxygen content on strength (A) and elongation (B), as well as hardness (C) of zirconium.

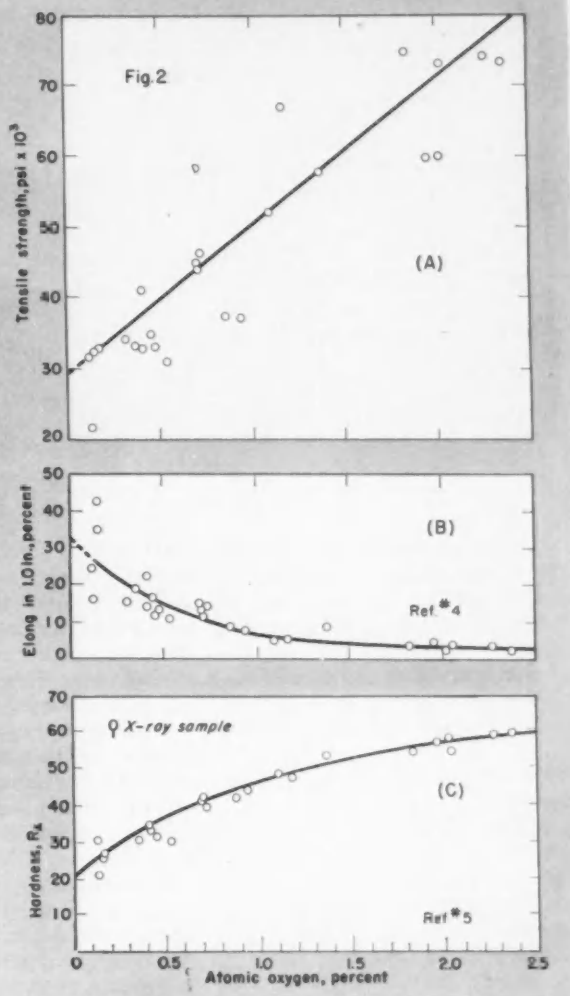


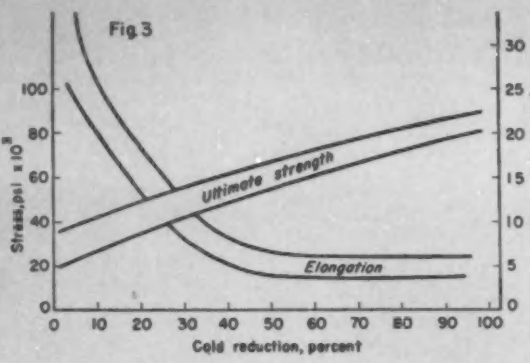

**Table II—Percent Impurity Content of Iodide & Chloride Zirconium**

| Element | Iodide (Ref. 1) | Chloride (Ref. 2) |
|---|---|---|
| Aluminum | 0.010 | 0.0010 |
| Boron | —— | 0.00002 |
| Calcium | 0.010 | —— |
| Carbon | <0.001 | —— |
| Chlorine | —— | 0.010 |
| Chromium | 0.001 | 0.0005 |
| Copper | 0.010 | 0.0006 |
| Hafnium* | —— | —— |
| Hydrogen | <0.020 | —— |
| Iron | <0.040 | 0.030 |
| Lead | <0.001 | 0.003 |
| Magnesium | <0.003 | 0.080 |
| Manganese | <0.001 | 0.002 |
| Molybdenum | 0.001 | <0.001 |
| Nickel | 0.010 | 0.0002 |
| Nitrogen | <0.010 | 0.005 |
| Oxygen | <0.010 | 0.012 |
| Silicon | 0.010 | 0.002 |
| Tin | <0.001 | 0.0001 |
| Titanium | <0.030 | <0.005 |
| Tungsten | 0.001 | —— |
| Zinc | —— | <0.005 |

*Unless special separation methods are used, hafnium stays with zirconium in refined material. This amount is often 2-3 percent.

decrease ductility.[4, 5] Although increased hardness and strength make the metal more difficult to work at room temperature, the effect of oxygen and nitrogen is not so important at temperatures in excess of 500 C. These impurities can also raise the recrystallization temperature. High-purity crystal-bar zirconium crystallizes after severe cold reduction to a fine-grain size with a half hour treatment at 600 C. Unalloyed zirconium with higher oxygen and nitrogen content must be annealed for a half hour at 800 C to obtain the same grain size. Fig 2 shows, the increase of strength, decrease of ductility, and increase in hardness with rising oxygen content.

INFLUENCE OF COLD WORK. The strength of zirconium can be more than doubled by cold working. Strain-free high-purity zirconium has a tensile strength at room temperature of about



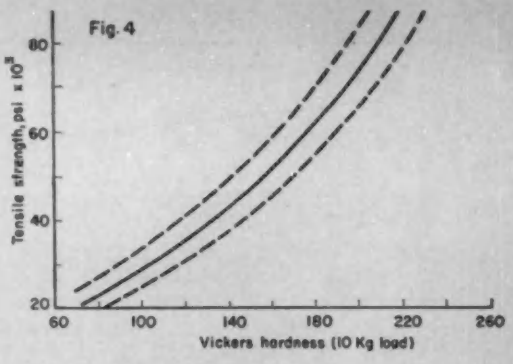




Fig. 3—Effect of cold reduction upon ultimate strength and percent elongation in iodide zirconium.

Fig. 4—Relationship between strength and hardness in iodide zirconium.

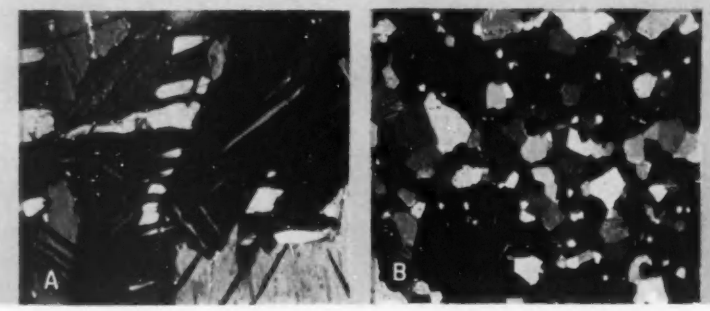



Fig. 5—Photomicrographs of (A) beta-annealed zirconium and (B) alpha-annealed zirconium. Magnification: 250 X.

35,000 psi, whereas the same material after approximately 97 percent reduction has work hardened to a tensile of 85,000 psi. Less severe reductions give intermediate strengths, but at some sacrifice in ductility, as shown in Fig. 3. The band in Fig. 4 reveals the strength-hardness relationship.

PREFERRED ORIENTATION. A strong directionality or preferred orientation is present in zirconium after a cold reduction of 90 percent or greater. Although different from the deformation texture, this post-anneal orientation has good strength characteristics. However, if the total deformation is obtained by alternate cold reductions of less than 50 percent and recrystallization anneals, the preferred orientation will be weak.[6] And after a final anneal similar to that which followed severe deformation, the texture remains weak.

It has been found that the strengths and ductilities of zirconium prepared in these two ways and having the same final grain size are markedly different. Severely cold reduced annealed specimens have a considerably greater yield strength and tensile strength than material subjected to the 50 percent cold-reduction-and-anneal cycle. The ductilities of the two materials are similar since the reduction in area is about the same for both, even though the elongation of the material with the reduction-and-anneal cycle is greater.

The relative dimensional change in the width and thickness directions during tensile tests on strong-texture sheet vary in a ratio of three or four to one, whereas comparable changes for the weak-texture material are much less. The strain hardening exponent, related to the rate of strain hardening, varies by a factor of two in the rolling direction as compared to the cross direction in the strong-textured material. This factor is often larger for strained material than for annealed material, depending upon grain orientation. With the weak-textured material, the strain hardening exponent is much greater for annealed material than for cold worked material.

INFLUENCE OF HEAT TREATMENT. In addition to recrystallization and grain growth during heat treatment after cold working, there is an allotropic transformation in zirconium at about 855 C. Above this temperature, zirconium is body-centered cubic whereas below this temperature, it is hexagonal close-packed.

Heat treatment above the transformation temperature usually changes the strength characteristics as compared to material heat treated at levels just below this temperature. Primarily, there is a considerable change in the distribution of impurities, since there is a relatively large difference in solubility of an impurity, depending upon whether the zirconium is in close-packed or body-centered form.

Usually, heat treatment at temperatures above the allotropic transformation markedly decreases the ductility of the metal and, in some instances, increases the strength. The photomicrographs, Fig. 5, show the difference in appearance of zirconium heat treated above and below the transformation temperature.

In the heat treatment of iron, heating just above transformation temperature into the austenitic region is done in an effort to refine the grain size or reduce the degree of preferred orientation. Similar treatment of zirconium does not give same results.

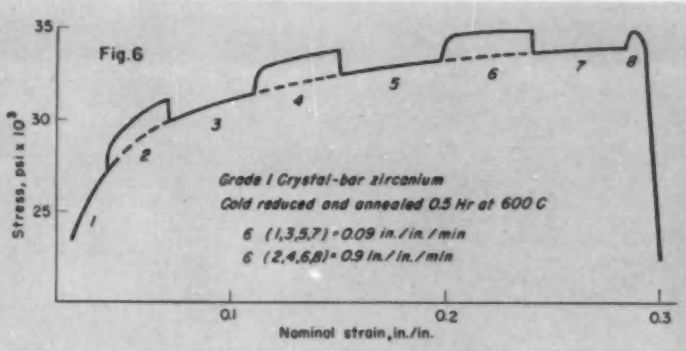
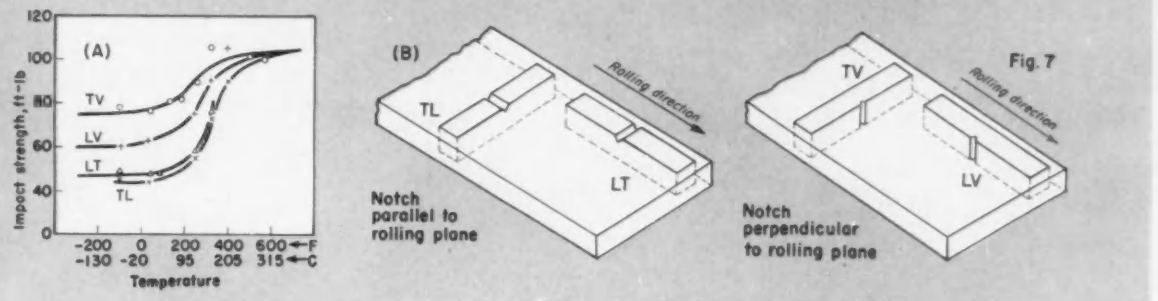


Fig.6
Stress, psi x $10^3$
Grade I Crystal-bar zirconium
Cold reduced and annealed 0.5 Hr at 600 C
6 (1,3,5,7) = 0.09 in./in./min
6 (2,4,6,8) = 0.9 in./in./min
Nominal strain, in./in.

Fig. 6—Typical stress-strain curve obtained when strain rate is varied by a factor in the order of ten.

Fig. 7—Impact strength versus temperature for iodide zirconium (A). Strength is influenced by specimen orientation and notch (B) in relation to original plate.




The influence of impurities upon the transformation temperature is known. Oxygen and nitrogen, which are readily absorbed by zirconium, raise this critical temperature, as does carbon which may be picked up during melting in a graphite crucible. Though hydrogen is the only gaseous element to lower the transformation temperature, there are many transition elements and a few non-transition elements which have the same effects.

INFLUENCE OF TEMPERATURE. The ultimate tensile strength and the 0.2-percent offset yield strength are shown in Fig. 1 (B and C) as a function of temperature for materials having several grain sizes. The ultimate tensile strength is considerably more dependent upon test temperature than is the yield strength. It is also apparent that zirconium does not become brittle at temperatures as low as —195 C.

INFLUENCE OF STRAIN RATE. Comparatively speaking, zirconium is not particularly rate sensitive at room temperature in the range of strain rates between 0.009 to 0.9 in. per in. per minute. A ten-fold change in strain rate produces a change in stress level of only about four percent. For example, a piece of zirconium metal strained at a rate of 0.009 in. per in. per min may have a stress of 30,600 psi, but when the rate is suddenly increased to 0.09 in. per in. per min the stress will rise to 3,1830 psi.

A typical stress-strain curve obtained when the strain-rate is varied by a factor of ten is shown in Fig. 6. Zirconium tested in the range from 25 to 370 C exhibits approximately the same rate sensitivity throughout. At 500 C, however, the sensitivity is significantly higher, and a ten-fold increase in strain rate from 0.009 to 0.09 in. per in. per min increases the stress from 11,150 to 14,170 psi, an increase of about 27 percent.

IMPACT STRENGTH. Zirconium remains ductile to very low temperatures if the impurities are kept to a low amount. This is true whether the metal is produced from the chloride process or the iodide process. Tests [8, 9] indicate that impact strength depends upon the orientation of the notch in the standard Charpy specimens as related to the rolling direction of the sheet, Fig. 7. If the V-notch is in a plane parallel to the direction of rolling, the impact strength is considerably lower than if the notch is perpendicular to the rolling plane. Hydrogen present in quantities greater than ten parts per million will decrease impact strength. Fortunately, hydrogen can be reduced by vacuum treatment or suitable heat treatment.

## REFERENCES

1. Raynor, W. M., *Foote Prints*, Vol. 24, No. 2, 1952, pp. 25-32.
2. Hayes, E. T., and Stephens, W. W., *Metal Progress*, Vol. 63, No. 5, 1953.
3. Gulbransen, E. A. and Andrew, K. F., *Journal* of Electrochemical Society, Vol. 96, December 1949, pp. 364-376.
4. Treco, R. M., *Transactions* ASM, Vol. 45, 1953, pp. 872-890.
5. Treco, R. M., *Journal of Metals*, Vol. 5, No. 2, 1953, pp. 344-348.
6. Keeler, J. H., Hibbard, W. R., and Decker, B. F., *Journal of Metals*, Vol. 5, No. 7, 1953, pp. 932-936.
7. Duwez, P., *Journal of Metals*, Vol. 3, No. 9, 1951, pp. 765-771.
8. Mudge, W. L., Jr., "Effect of Hydrogen on the Embrittlement of Zirconium and Zirconium-Tin Alloys," Zirconium and Zirconium Alloys, 1953, ASM, Cleveland, Ohio.
9. Shelton, S. M., "Zirconium Alloy Investigations, U.S.B.M., Rept. 11, Summary of Progress, March 15, 1950-March 15, 1952, BM11-33, Albany, Oregon.

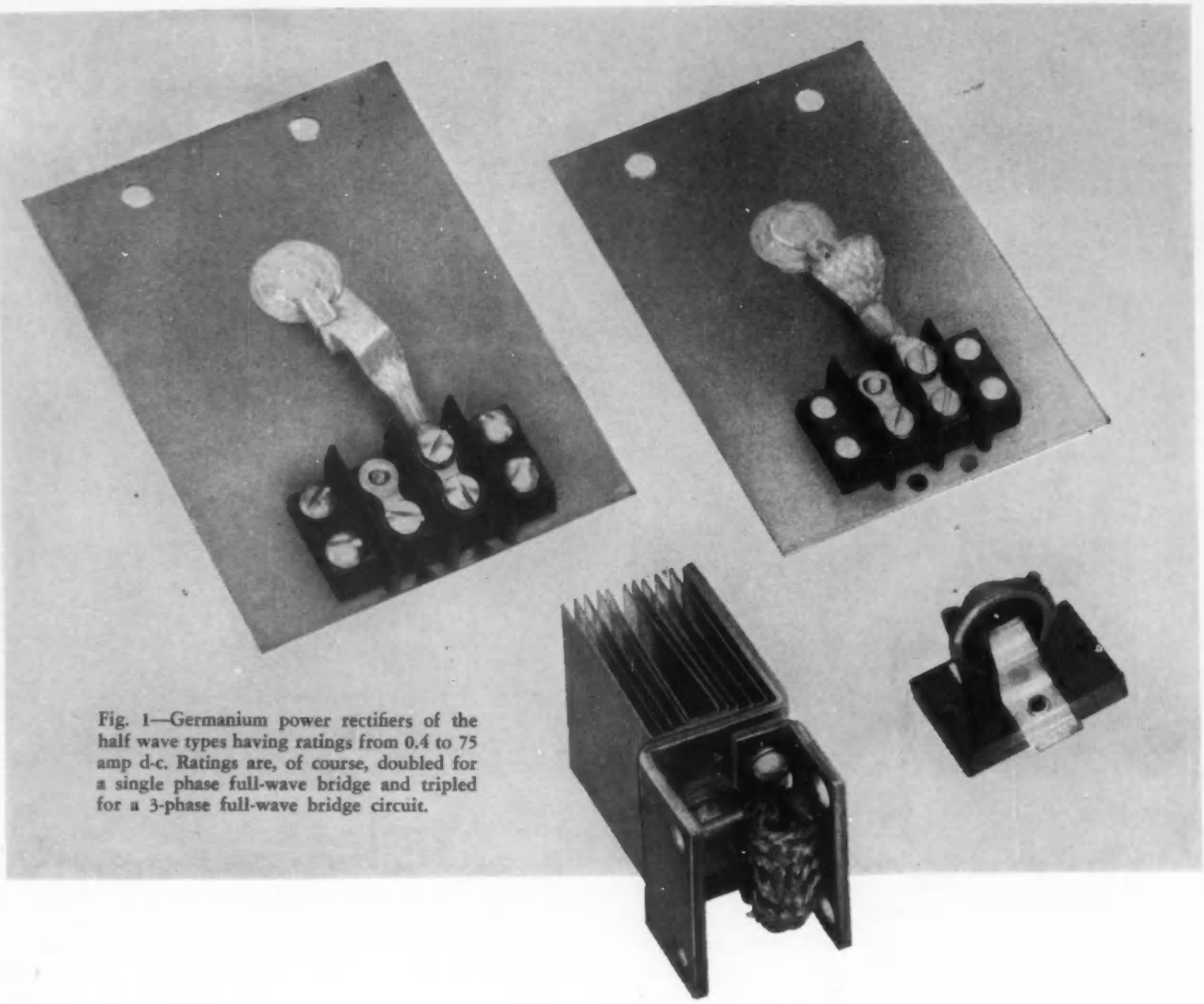


Fig. 1—Germanium power rectifiers of the half wave types having ratings from 0.4 to 75 amp d-c. Ratings are, of course, doubled for a single phase full-wave bridge and tripled for a 3-phase full-wave bridge circuit.

# Germanium—New Frontier

WHILE INCREASING ATTENTION has been paid to the role of germanium in the electronics field, equally interesting possibilities lie in the opposite direction—that of high power rectification. In the range of 25 to 125 v d-c and from capacities of 10 to several hundred kw, germanium offers efficiencies and operating economies now only obtainable with mercury arc converters operating at much higher levels of voltage. Compared to other types of metallic rectifiers, the reduction realized in physical size per kw of output is equally significant as the miniaturization trend in the electronics industry. In service life, germanium rectifiers point up an additional advantage. Tests now in progress for over 20,000 hr at current densities up to 100 amp per sq cm of active area indicate no detectable change of a permanent nature. Compared to other types of metallic rectifiers which show a definite forward aging trend in 10 to 20,000 hr, complete absence of this aging phenomena—even at very high current densities—gives a sound basis for predicting a long term operating life.

## Electrical Characteristics

*Cell Current Ratings.* For practical application, the small germanium cells are built into assemblies to permit rapid transfer of heat. Fig. 1 shows several different assemblies currently being used to accomplish the desired degree of heat transfer for operating at various current densities. By mounting the cell, shown in Fig. 1, on a small copper plate and convection cooling it at normal room temperatures, current ratings ranging from 2 to 10 amp are obtained. The ratings, of course, depend upon the size of the plate and the voltage rating of the cell. A small amount of forced air, about 150 to 200 fpm, permits the current to be doubled.

The fin type assembly also shown in Fig. 1 is used for power applications

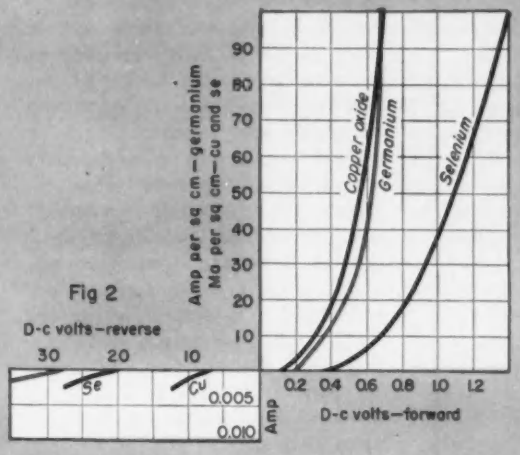
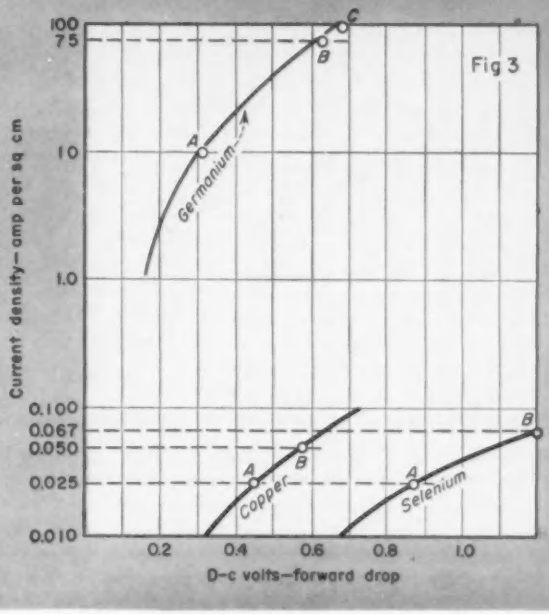



Fig. 2—Forward and reverse d-c volt-ampere characteristics for germanium, copper-oxide and selenium rectifiers. Current density is based on 1 sq cm of active area, being plotted in amperes for germanium, and milliamperes for the other two types.

Fig. 3—Comparison of the forward volt-ampere characteristics of the three types of rectifiers with the current density being expressed logarithmically. Points A, B and C denote maximum convection cooled, fan cooled and liquid cooled operating conditions respectively.




C. E. HAMANN, General Electric Co., Lynn, Mass.

# for High Power Rectification

**Initial applications of germanium power rectifiers demonstrate significant advantages in: 1) Higher cell ratings; 2) lower losses; 3) longer life; 4) higher efficiency; and 5) marked cell size reduction compared to selenium and copper-oxide units.**

and permits currents up to 75 amp per cell with 1,200 fpm of air. A similar assembly using liquid cooling allows the cell to be operated at currents up to 100 amp.

*Cell Voltage Ratings.* Specified in terms of maximum recommended rms input volts, germanium cells are presently available in ratings of 15, 30, 50 and 65 volts. Smaller area cells are already available in voltage ratings up to 125 rms volts input.

For a given a-c voltage input, the d-c voltage output will depend on the type of rectifier circuit and the nature of the load. In a single phase bridge with resistance loading, the d-c output voltage will measure 87 to 88 percent of the applied a-c input. Assuming that the bridge is operating at or near its optimum voltage and current rating, this is a close approach to the value of 90 percent for a theoretically perfect rectifier. Under similar conditions in a 3-phase bridge circuit, the d-c output voltage will measure about 132 percent of the applied a-c voltage compared to 135 percent for the theoretically perfect rectifier with zero losses.

*Current Density.* A logical comparison between the germanium power diode and the other types of metallic rectifiers now being used is on the basis of current density per unit area. Fig. 2 shows germanium, selenium

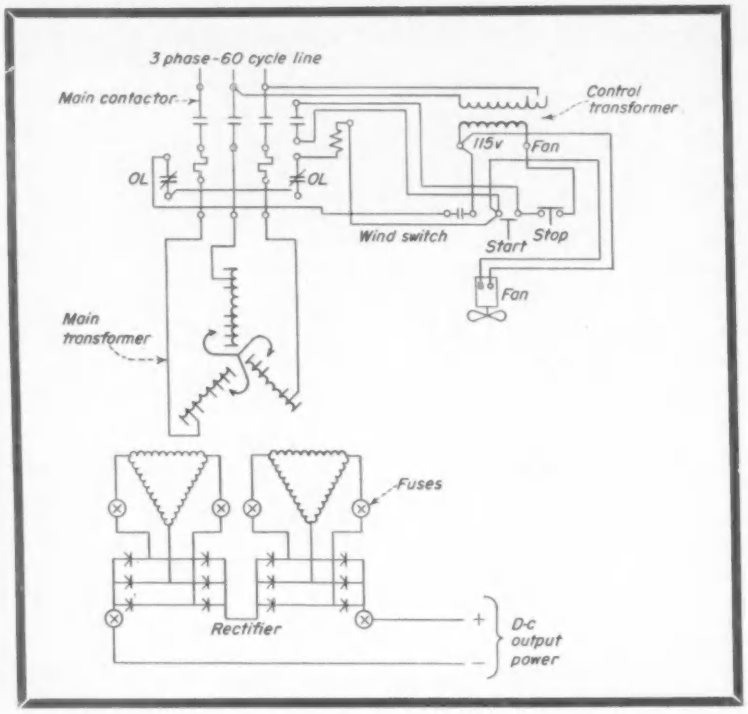



**Fig. 4—Internal wiring for 25-kw germanium conversion unit. Wind switch protects against fan failure and main contactor gives thermal overload protection.**

and copper-oxide compared as to their volt-ampere characteristics per active area of one sq cm. Germanium has the same forward voltage drop at 100 amp as does copper-oxide at 100 ma, and about half the drop exhibited by selenium at 100 ma. However, it might be a logical consideration to conclude that copper-oxide could be made as efficient as germanium by simply increasing the active area a thousand times. This is true, but only at the limited voltage output of the copper-oxide cell. To approach the optimum voltage output of the germanium cell, several copper-oxide cells must be operated in series with voltage drop rising proportionately.

The same forward volt-ampere characteristics are shown in Fig. 3, current density being expressed logarithmically. Accepted normal current density for both selenium and copper-oxide is 0.025 amp per sq cm at half-wave rating. Rating of germanium is 10-amp per sq cm convection cooled and up to 100 amp with liquid cooling.

*Reverse Volt-Ampere Characteristics.* Equally significant is the comparison between the reverse volt-ampere characteristics of the different types of metallic rectifiers. Compared to the permissible high forward current for germanium, the reverse leakage current is very low. But the curves in Fig. 2 do not tell the entire story. Germanium gives the appearance of having a higher reverse leakage value than either selenium or copper-oxide at their respective operating voltages. However, if the effective area of either selenium or copper-oxide is increased to equal the current output of germanium, their leakage currents increase by approximately the same amount. These values then are much larger than that for germanium.

The peak inverse voltage of a germanium cell is a critical point in its reverse current characteristics, and a point beyond which the cell deteriorates rapidly. If this value is exceeded, even momentarily, the cell is usually destroyed. Thus, what happens to the cell is the reaching of a point beyond which a dielectric breakdown occurs. Because of this factor, the recommended rms input voltage ratings are very conservative, being something less than half of the measured peak inverse voltage for any particular cell. Production cells are graded and rated on this basis. Cells of various voltages ratings, therefore, will exhibit approximately the same leakage values at their respective voltage ratings.

*Series and Parallel Operation.* Parallel operation of germanium cells is feasible if sufficient care is used in matching the cells. Also, there appears to be no limit to the amount of current that can be handled by paralleling the proper number of cells.

At the present stage of development, considerable difficulty has been encountered in operating germanium cells in series and obtaining an equal division of voltage. Current practice is to use multiple secondaries on the transformer and to feed each bridge from a separate secondary. By this arrangement, the individual bridges can be operated in series to obtain any desired voltage output. D-c voltages up to 250 v are both practical and economical by this method and are presently being used with existing equipment. As development in this area continues, higher voltages will soon become practical. A typical internal circuit showing a series design is illustrated in Fig. 4. The diagram shows two 3-phase bridges in series for a 125 v d-c output.

*Operating Efficiency.* The over-all efficiency of the germanium cells is largely dependent on the transformer design. In application, the advantages of gaining an extra point in efficiency must then be carefully weighed against the added cost of the

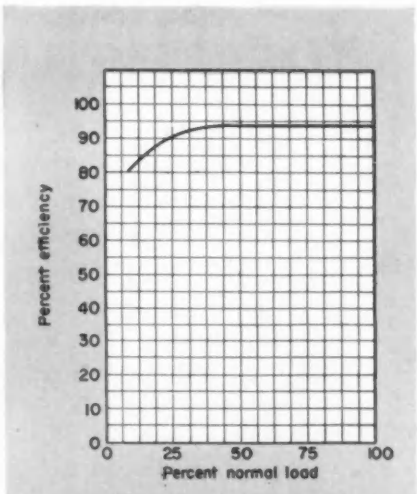



**Fig. 5—Efficiency curve of a germanium rectifier. Efficiency remains flat down to a fraction of full load current.**

transformer. As shown in Fig. 5, if the germanium cells are used with a transformer of economical design for rectifier equipments as low as 50 to 100 kw, the over-all efficiency is 94 percent. In a 3-phase bridge circuit, the efficiency of the germanium cells at optimum ouput is between 98 and 99 percent. Over-all efficiencies of power rectifiers including losses of transformers, controls and cooling systems may be in the range of 92 to 95 percent depending on the design of the components.

## Temperature Characteristics

Similar to other types of metallic rectifiers, germanium has a negative temperature characteristic. At a current density of approximately 100 amp per sq cm, the forward voltage drop decreases about one percent for each 4 C rise in cell temperature. This gives a corresponding straight line reduction in forward watts loss. However, the effect of temperature on the reverse leakage characteristic must be carefully considered as the change in cell resistance in the reverse direction is exponential rather than linear. Fig. 6 shows this reverse current-temperature characteristic relationship. Note the tendency for the reverse current to run away at cell temperatures approaching 100 C. In this area, recommended ratings are again ultra conservative to assure a wide margin of safety in the initial application of germanium.

Following the practice of the metallic rectifier industry, all ratings are based on 35 C maximum ambient temperature. Thus, with a 35 C ambient and a cell rise of 25 to 30 C, the total cell temperature is maintained well below the danger point. For higher ambients, derating tables are shown in Fig. 7. Since the cell temperature rise is caused by the combination of forward and reverse losses, it can be reduced either by derating in current or derating in voltage. Better utilization is obtained by derating in voltage which controls the reverse losses. Referring to Fig. 7, if rated voltage is maintained and current derated, only 35 percent of rated watts output is allowable at 50 C ambient. But if current is maintained and voltage derated, 40 percent of normal output can be obtained from a 65 v cell, and better than 70 percent from a cell rated 30 v rms with a 50 C ambient.

## Fault Current Protection

Because of the very low losses in the germanium cells, fault currents are often limited only by the short circuit capacity of the transformer feeding the rectifier. Faults of this nature then must be cleared very quickly within a few milli-seconds, to avoid damage to the equipment.

The most economical method of protection is fusing. Repeated short circuit tests with available types of fuses show that the circuit can be cleared within 3 to 10 milli-seconds without damage or adverse effects on the germanium cells. Under conditions of essential service, where automatic reclosure is mandatory, a short circuiting device can be placed across the cells with suitable breakers in the a-c input side. This is similar to the method used for the protection of mercury arc and mechanical rectifiers. A typical internal wiring and protective equipment circuit is illustrated in Fig. 4. Special, fast operating fuses supply both internal and external short circuit fault protection.

## Cell Cooling

With cell operating temperature such an important factor, efficient and economical cooling methods are necessary for the cell's maximum utilization. Both forced air and liquid cooling are currently being investigated. Results obtained indicate that with fan cooling and when operating at normal rated current, the cell temperature rises to normal and levels off after a period of about one minute. At twice normal current, rated temperature is reached in approximately 20 seconds. Using liquid cooling, the time lag, of course, is longer.

In general, the fan-cooled type of construction is proving to be suitable for indoor installations which are rea-

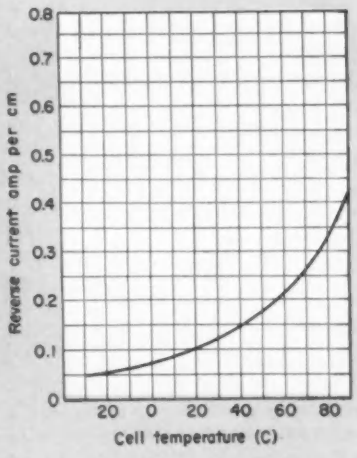



Fig. 6—Reverse current-temperature characteristic of a germanium cell rectifier operated at rated voltage.

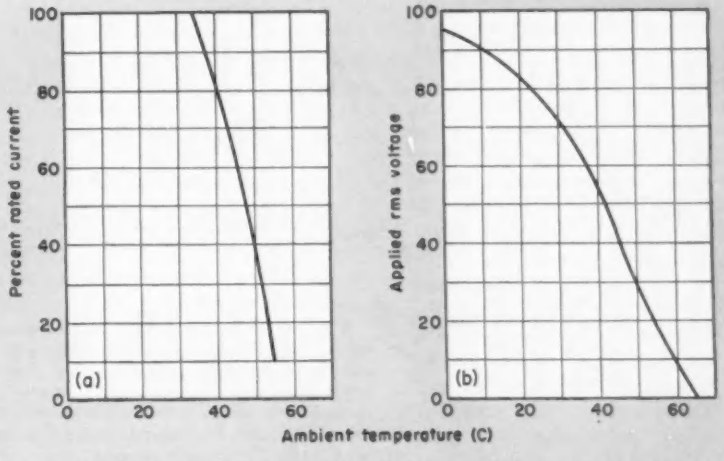



Fig. 7—Current derating chart is shown in (a); permissible operating voltage of a nominal 65 v rms cell at various temperatures when operated at rated current is indicated in (b). Note higher output by voltage derating.

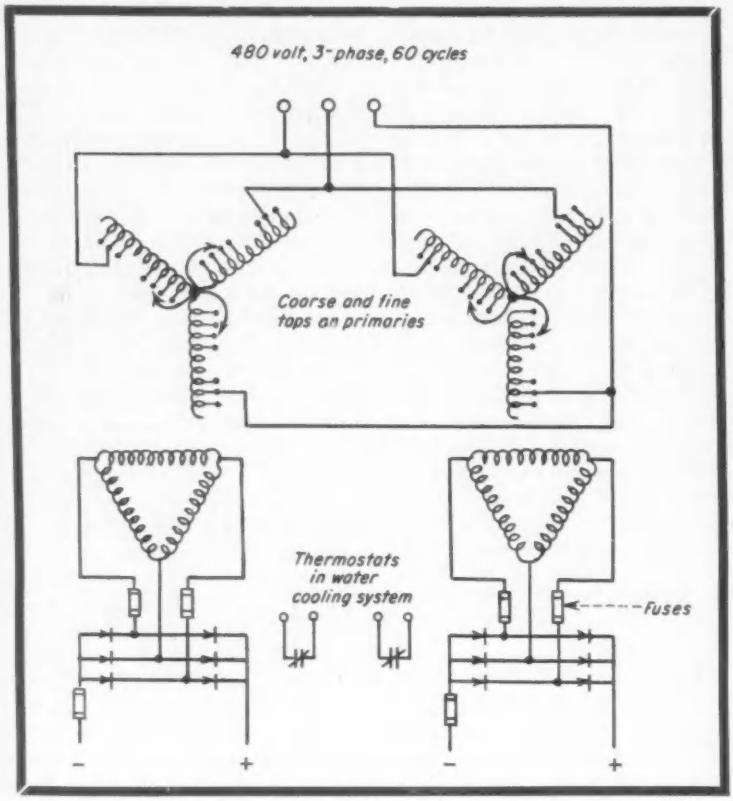



**Fig. 8—Wiring diagram for 120 kw rectifier unit. Design consists of four individually fused bridges in parallel on each side. Outputs can be connected in series or parallel, with switchgear and control equipment external to the unit.**

sonably free of corrosive fumes and excessive moisture and where ambient temperatures do not exceed 35 C. Where higher ambient temperatures or adverse atmospheric conditions are encountered, liquid cooling appears to be more advantageous. Early designs were built around a construction consisting of soldering the germanium cell between two blocks of copper and then conducting the water between them. While this method was efficient, electrolysis and, if water and ambient temperatures were significantly different, sweating problems developed.

A method which avoids the disadvantages of direct water cooling but retains its inherent advantages is to seal the germanium cells in a steel tank containing a suitable liquid coolant. The coolant conducts heat from the rectifier cells, transferring it to water which is circulated through copper coils. By this design, the cells are completely protected from adverse environmental conditions, being hermetically sealed in a protective liquid. Since the cooling water does not contact any current carrying parts, electrolysis is prevented.

## Applications

A commercially available 25 kw, fan-cooled power unit shown diagrammatically in Fig. 4 employs two 6-cell, 3-phase bridges, each connected to a separate transformer secondary winding. Using a series connection, the output is nominally 200 amp at 130 v d-c. A parallel connection will give 400 amp at 65 v d-c, a convenient rating for some chemical applications.

This 25 kw unit is a convenient size power package which can be readily paralleled in groups for any desired output. One installation is constructed of 6 units operating with saturable reactor type of voltage regulator to deliver 150 kw for a hydrogen-oxygen installation.

Another commercially available unit, a 120 kw rectifier permitting duel outputs of 2,000 amp at 60 v d-c or 1,000 amp at 120 v, is shown in Fig. 8. Adequate cooling for continual duty application at full load rating has been obtained with 2 gpm of tap water. Three gpm was sufficient for extreme summer conditions with tap water temperatures running as high as 85 F. This dual 60 kw sealed tank assembly serves as a basic building block. It permits the design of almost any desired output rating by grouping a number of tanks in various series and parellel combinations along with suitable transformers and controls. The latest step in this design are two units, each rated 6,000 amp, currently being constructed for a sintering furnace application.

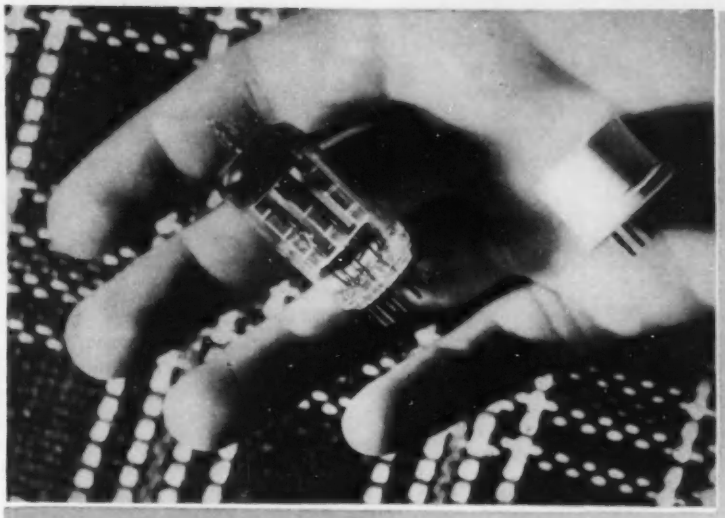
Charging of telephone central station batteries appears to be another future field of application. Since voltage and current requirements are close to the optimum ratings of germanium, economic utilization of germanium seems assured. Prototype rectifiers for this service are currently undergoing laboratory tests with several thousand hours of successful operation now recorded.

Germanium appears to be equally well suited for the charging of large industrial truck batteries, and current tests for application have been successfully progressing for over a year. Another application presently in the design stage is a 10,000 amp unit to power a d-c arc furnace for reduction of titanium sponge.

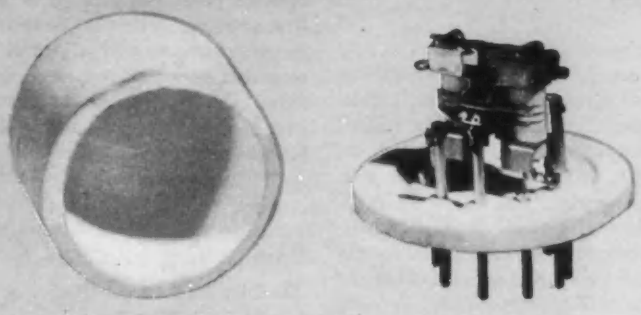
***While there has been much discussion regarding the potential role of silicon as a material which will replace germanium and give greatly improved devices, evaluation still does not confirm such statements. Though silicon will operate at a much higher temperature and reduce the back current, the problems inherent in its production remain the principal stumbling block to its use. Also, its greater sensitivity to temperature changes and its resistance in the forward direction are sufficient to limit its adoption in certain applications.***

***In view of these difficulties, the future seems to lie in the development of compound semi-conductors utilizing two or more elements. This, in turn, will permit a careful tailoring of the end material to obtain the characteristics desirable for particular applications. Work done to date seems to substantiate a promising future. But a considerable development program lies ahead before widespread commercial use.***

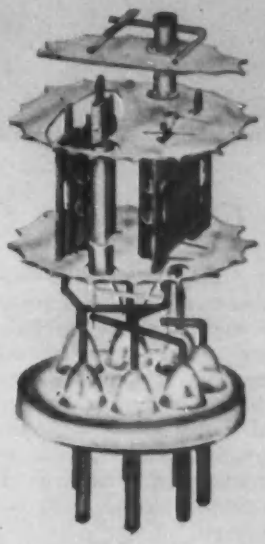
# TECHNICAL NEWS



LESS THAN HALF the height of the conventional tube (left), the new tube's simplicity of design (lower left), is compared to the structure of the old tube (below). The ceramic used for the envelope and stem is aluminum oxide, permitting bake-out temperatures up to 950 C.



NEW



OLD

## Electron Tubes Take on New Look

IN DESIGNING their new electron tube, Sylvania Electric Products, Inc. has eliminated many of the drawbacks associated with the conventional tube—namely, problems of: vibration and shock, plus wide temperature fluctuation, all of which add up to tube failure; and the inability to be adapted to automatic production methods. The result is the opening up of a broad area of new applications.

The new "stacked" tube features a ceramic envelope or cap, above, as opposed to the usual glass bulb, and the various parts are stacked one on top of the other in the assembly process, a procedure quite different from conventional methods. Another feature is the use of ceramic spacers instead of mica. According to Sylvania president, H. Ward Zimmer, "These design innovations not only make possible unique performance and reliability, but also permit high mass production because of design simplicity."

While the feature of new tube is the ceramic envelope, the stacked structure permits the use of either a glass or a ceramic envelope, depending upon the ultimate application. The ceramic envelope is used for the severe environmental conditions. The complete mount is assembled on two small pins. First a plate, a ceramic spacer, a grid, a ceramic spacer, a cathode, a ceramic spacer and so on until the top is reached. When the stack is completed, the small pins are riveted. The sealing is done with a "bell-jar" system, a glass dome under which the stacked parts are placed, air evacuated, and the envelope sealed over the stacked parts. The ceramic used is aluminum oxide.

Also, the substitution of ceramic spacers for mica spacers contributes to the sturdiness of the tube without reducing performance. In extreme operating conditions, mica will spall and flake out under vibration. The tubes have been thermally cycled from room temperature to 450 C without damage.

# First Computer Center

THE FIRST Analog Computation Center, available to industry on a rental basis, was opened recently by Electronic Associates, Inc. near Princeton, New Jersey. Available for the solution of a host of problems, the center will provide a staff of scientists available for problem analysis as well as equipment, which may be rented on an hourly, weekly, or monthly basis for problem solution.

Lloyd F. Christianson, president of Electronic Associates feels that, "The new center will prove particularly beneficial to the smaller companies which have not yet found it feasible to invest in their own computation facilities. One of its purposes is to educate business and industry on the capability of Analog Computers to solve many problems with enormous savings in time."

To each problem the Center will assign the necessary men experienced in the use of analog computers to evaluate, set-up, and solve the problems. When individual situations require specialized aid, the staff will be assisted by experts from various research institutions and universities in the area. These specialists will follow the problem from the initial stages of analysis, through the processing in the computer, and the final analysis of the results of the computation. A comprehensive report with specific recommendations is then prepared.

The equipment at the Center includes: a dual control console; 96 operational amplifiers; 15 servo multipliers; 4 servo resolvers; 5 servo type function generators; a two-channel x-y recorder; and a 6-channel curvilinear recorder. Simultaneous solution of two problems is possible, or, the entire system can be used to solve more complicated problems.

## NBS Sets Up New Radio Research Laboratory

SO AS TO MORE EFFECTIVELY SERVE the interests of science, industry, and the government, the new program of The Central Radio Propagation Laboratory (CRPL) of the National Bureau of Standards has resulted in the creation of a new multi-million dollar radio research laboratory in Boulder, Colorado.

Perhaps of special interest to design engineers is the service rendered by the Measurement Standards Laboratory, one of several sub-divisions of CRPL. According to the National Bureau of Standards, the need for standards of electrical quantities applicable to the constantly expanding field of electronics had been recognized for some time, but the establishment of suitable standards has been complicated by rapid developments in the field and the continuous extension of the useful frequency range. Even low (audio) frequency standards have not yet reached the perfection generally desired, and standards at all frequencies are continuously being improved. CRPL claims to maintain a continuing program aimed at developing basic and better transfer standards of measurement, instruments, instrumentation techniques, methods of measurement, and analysis of the electrical quantities.

The lack of authentic comparative information on the characteristics of powdered iron and other magnetic materials was responsible for a research program aimed at the development of instruments and methods to accurately measure permeability and loss factor. The resulting instrument is known as an r-f permeameter and serves as a secondary standard. It is now possible to establish specifications for powdered iron based on the accurate results of NBS instruments and standards.

## Engineering Students To Spend Less Time In Major Field

THE DOMINANT THEME of the 62nd Annual Meeting of the American Society of Engineering Education recently held at the University of Illinois was that more time should be devoted to the basic sciences, engineering science, and the humanities—at the expense of engineering art or practice. The meeting, said to be the largest in history, attracted more than 1400 engineers, mostly teachers from colleges all over the country, and many foreign countries.

The interim report of the ASEE's Committee on Evaluation of Engineering Education showed the move in this direction. This proposal would have all engineering students—whether majoring in chemical, mechanical, electrical, civil, or other branches of the field—study in common almost five-sevenths of the total course. Only two-sevenths would be concentrated in the field of the major, and almost half of this would be as electives.

## High Density Shielding Material

TO SHIELD small laboratory beakers, flasks, distillation columns, and the like, Argonne National Laboratory has prepared a high density concrete composed of lead shot, lead powder, and a cement binder, which has a density of 515 to 525 lb per cu ft.—about twice that of most densified concretes. It is about 1¼ times more effective than steel for gamma rays of energies up to 1.33 Mev.

Simple forms of wood or fiber can be used to contain the material, which is easily hard mixed and which sets in 8-12 hours. It develops a 2200-2500 psi compression strength within 30 days. Cost of the new material is $0.26 per pound.

## World's Largest Auto Test Center

UNDER CONSTRUCTION for more than 2½ years, Chrysler's new multi-million dollar, 4,000 acre Engineering Proving Grounds is now in full scale operation. According to James C. Zeder, V. P. of Chrysler Corp., and Director of Engineering and Research, "We are able to duplicate almost any road condition found in the world, except for off-season conditions, rugged mountains, and excessive salt problems."

The world's largest automotive proving grounds includes a concrete oval high-speed track 4.7 miles long; two concrete straightaway tracks, 2.23, and 1.59 miles long; an 8.4 gravel endurance road; three specially designed inclines with grades of 7, 15, and 32 percent; and a number of obstacle courses. The six-lane high-speed oval track is designed for vehicle speeds up to 140 mph.

## Washer Takes Guess Work Out of Bolt Preloading

A NEW METHOD of preloading of bolts used in aircraft assembly, developed and placed in use by Douglas Aircraft, will give an average tension preload of 80 percent of the desired bolt preload, with slight deviations. Although it consists of nothing more than two concentric steel rings, Douglas engineers are certain that it will result in a sharp increase in the fatigue life of the bolts, and tighter assemblies. In addition, it does away with torque wrenches.

The "PLI" (preload indicating) washer works like this: the inner ring, which is thicker than the outer ring, takes the load when the unit is tightened, allowing the outer ring to move freely. Continued tightening of the nut compresses the inner ring until the two rings bind. When the outer ring can no longer be moved, the desired preload has been reached. The load at which the bind occurs can be controlled by the choice of washer dimensions, and the washer material.

# Pre-dryer and Pre-heater For Plastics Machines

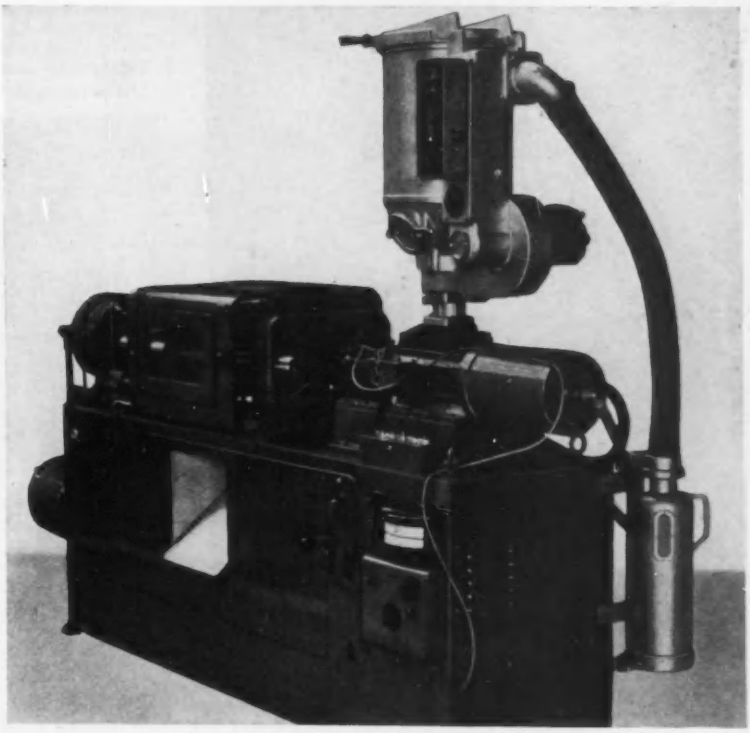
SHOWN MOUNTED on an injection molding machine below is a device called the Continator, designed by W. F. Hoffman & Co. of Copenhagen, Denmark. Used in the plastics industry for both injection molding and extrusion machines, the continator is a pre-dryer and pre-heater for eliminating the effects of humidity and other atmospheric conditions on the materials entering the machines.

Compared to the old method of pre-drying in cabinets, the continator will prevent the damage to materials caused by one tray spilling into another. It also cuts several work-steps required by the cabinet method. Also, by proper pre-heating, output per molding machine can be increased.

The material is filled directly into the continator from the drums, eliminating the dust problem. As an indication of its capacity, it holds about 100 lb of cellulose acetate.

Two standard types are available: one is for all types of machines up to 4 oz capacity; and the other for injection and extrusion machine of up to 16 oz capacity.

At the lower right is the optional moist-off filter for use where air supply is unusually humid.

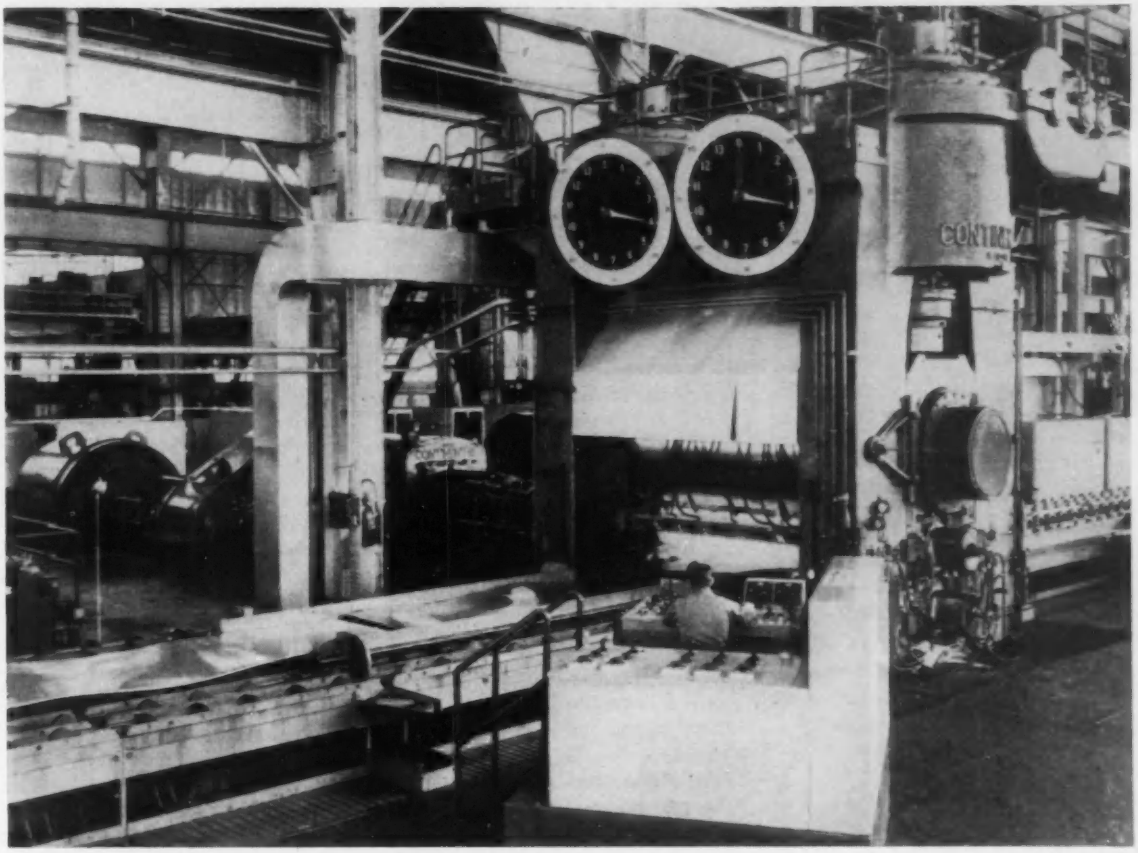


# THE NEWS IN PICTURES

THE NAVY COMPARES its largest and smallest jet plane, with the recently unveiled bantam attack plane, the A4D Skyhawk in front, and the long-range, twin-jet carrier plane, the A3D Skywarrior in back. The lightweight design philosophy used resulted in the A4D being completely built in 18 months from the beginning of design. Both planes are products of Douglas Aircraft Co., Inc.

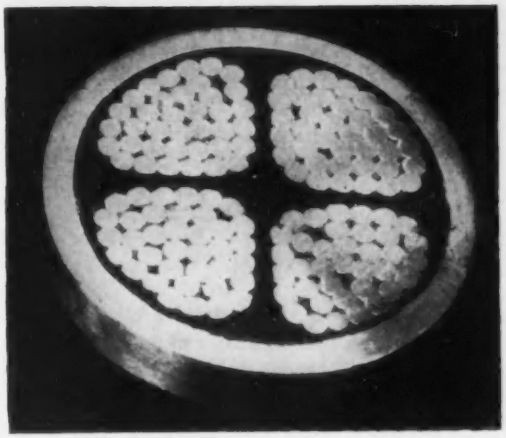
WORKMAN IS SHOWN removing a 41 lb aluminum die cast flange for a cable reel from the new 72 in. die casting machine, developed by The Doehler-Jarvis Division of National Lead Company in conjunction with the Kaiser Aluminum & Chemical Corp. Castings up to 75 lb are possible. The machine can be operated at 30 shots per hour on such a job. With zinc, castings up to 200 lb are contemplated.

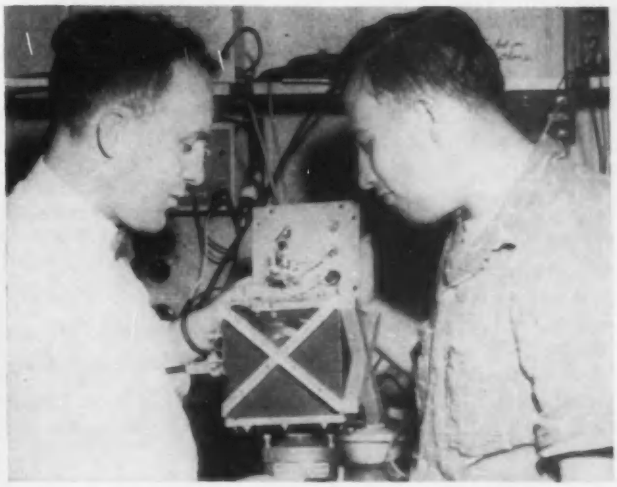
GEON RIGID VINYL PLASTIC, introduced several years ago by B. F. Goodrich Chemical Co. is shown here after being stamped by conventional metal stamping machinery, rather than with the customary rigid vinyl plastic injection molding or forming machines. The boxes were made from 1/20 in. thick sheeting embossed on one side with a weave-like texture, and fed under a bank of strip heaters to raise its temperature to 275 F. Cycle time was 10 seconds.



RECENTLY PUT INTO OPERATION at The Aluminum Company of America's Davenport, Iowa plant is this 144 in. tapered sheet and plate rolling mill. The huge mill will produce tapered sheet for wing and tail skins, and spar webs for some of the largest aircraft. Maximum sheet width is 10 ft; length, 40 ft; and maximum thickness at the heavy end, 1.50 inches.

A CROSS SECTION of a low voltage power cable, aluminum sheathed by the direct extrusion process. For years a process used in most European countries, General Cable Corp. has arranged for the purchase of an aluminum sheathing press from a West German firm. The press will give sheathed cables of lower cost, lighter weight, and greater mechanical strength.





TWO SCIENTISTS at Armour Research Foundation of Illinois Institute of Technology examine the "sound box", a high intensity sound chamber which will test the effects of jet and rocket engine noise on electronic components. Noises of 150 decibels can be produced. The sounds are supplied by a random noise generator, and an audio-oscillator, a device for generating pure tone sounds.

# ENGINEERING SOCIETY NEWS

## ASME To Discuss Engineering Training

ONE OF THE HIGHLIGHTS of the Fall Meeting of the American Society of Mechanical Engineers to be held in Milwaukee, Wis. on Sept. 7 and 8, will be a panel discussion on "Developing the Young Engineer." George F. Nordenholt, Editor of *Product Engineering* will be moderator. The panel members are: George Habach, Executive Engineer of Worthington Corporation; Walter Schmitter, vice President in Charge of Engineering, Falk Corporation; Joseph Mulheim, Chief Engineer of Jack & Heintz; F. R. Gruner, Assistant to the Manager, Processing Machinery Department, Allis Chalmers Mfg. Company; and W. M. Owen, Assistant Chief Engineer, Caterpillar Tractor Company.

## Selective Service Policy On Engineers

THE AMERICAN CHEMICAL SOCIETY leveled a blast at Maj. Gen. Lewis B. Hershey, Selective Service Director, claiming that the policy of Selective Service on scientists and engineers is contrary to law and detrimental to the true national interest.

Alden H. Emery, executive secretary of the Society, criticized the decreasing selectivity of Selective Service, and said that, "While the law is designed to enable each man to serve where he can contribute most to national health and security, officials seem to be paying less and less attention to this question in weighing deferments for scientists and engineers."

Figures show that Selective Service is being less selective according to Mr. Emery. "The number of occupational deferments dropped from 32,439 to fewer than 21,000 during the past year and a half; and between December 1953 and March 1954, deferments have dropped especially fast, with only 2,986 being deferred in that period."

The Defense Manpower Policy No. 8 issued in September 1952 stated that: "The Selective Service System shall continue to apply to scientists and engineers the policy formulated by Congress for classifying in a deferred class registrants whose activities are necessary to the maintenance of the national health, safety, or interest." Mr. Emery claims that this rule has resulted in various interpretations, for recently the head of Selective Service in one state informed his various boards that, "The only group of scientific personnel who should be considered for any extended deferred period are those engaged in the production of atomic weapons by The Atomic Energy Commission or their subcontractors, and those engaged in the design and manufacture of aircraft for the purpose of transporting atomic weapons."

Along the same lines is an item received from the Engineering Manpower Commission of Engineers Joint Council:

An official of an Eastern university, who recommended continued student deferment for an outstanding senior accepted for graduate work, received the following letter from a Michigan local board: ". . . This board feels that in deferring a registrant for a period of 4 years to enable him to secure a college degree that he should be willing to submit himself for military service at the completion of his fourth academic year. Michigan State Director of Selective Service, Colonel Arthur B. Holmes supports this board in this contention, and unless a registrant is pursuing a course in The Healing Arts, he will be processed for induction in the first draft call after his graduation from college."

## Increased Demand For Engineering Grads

IN AN ANNOUNCEMENT by the Engineering Manpower Commission of Engineers Joint Council, and the Scientific Manpower Commission, an annual employment survey indicates that there will be a 4 percent increase in the demand for college men and women in industry, as compared with June 1953. This survey, directed by Frank S. Endicott, director of the Northwestern University's placement service, indicated that the increase is mostly in science and engineering, with the prospects for graduates without technical training about the same as in 1953. Starting salaries about 6 percent higher.

Between 1952 and 1953 there was a drop of 11 percent in the number of men receiving bachelor's degrees, and projections for 1954 indicate another drop of 11 percent. Graduates at the Master's level are off 4 percent, but there is an 8.1 percent increase in Doctorates.

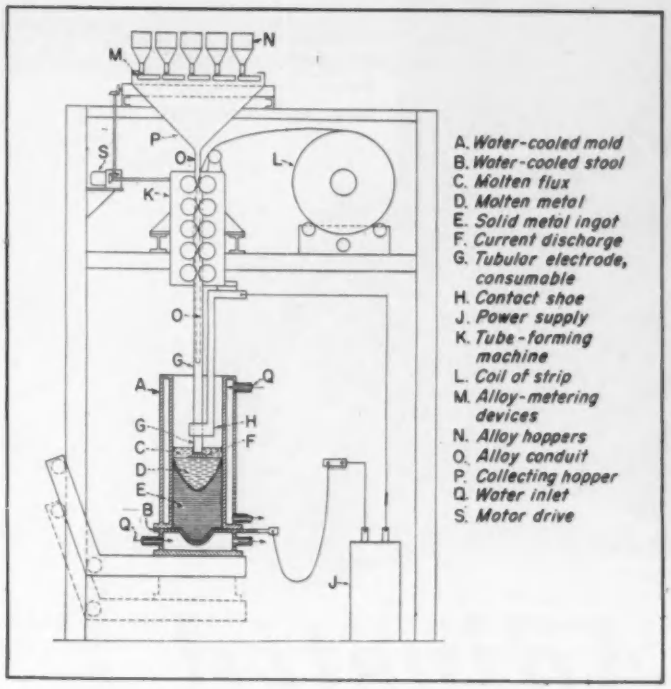
## New Research Studies Arranged

THE NATIONAL SCIENCE FOUNDATION has announced that arrangements have been made for three additional studies of research and development to be conducted by Federal and private survey groups. These studies are:

1. Survey of Industrial Research & Development.—The ultimate scope will be to get data on research personnel, expenditures of research, capital investment in research facilities, and relationship of research expenditures to corporate sales and invested capital. Also, information on how companies determine size of research programs, how they appraise the return on research, and the effect of taxes and other government policies on industrial research. Conducted by the Bureau of Labor Statistics of the Dept. of Labor.

2. Survey of Research by Trade Associations and Similar Organization—Approximately 16,000 trade associations in the United States will be surveyed, along with certain professional societies, largely supported by industry, and other types of cooperative industrial research organizations. Conducted by the Battelle Memorial Institute.

3. Survey of Research at Nonprofit Institutes and Commercial Laboratories.—The research programs of the 50 to 100 independent nonprofit research institutes and the estimated 250 to 400 commercial research laboratories will be explored by the Maxwell Research Center, Syracuse University.



**OPERATOR INSPECTS** automatic metering device which controls the flow of the granulated alloying materials into the electric ingot machine. Materials are stored in bins above.

# The Electric Ingot Process

SHOWN ABOVE in the diagram is the operation of the M. W. Kellogg Company's method for producing special alloy steels. Often called "super alloys," they must perform properly at high temperatures and speeds, have qualities of high tensile strength, good yield point, and good ductility.

In making turbine wheels for jet engines, Kellogg felt that an improvement on existing methods for producing these special alloys was necessary. The result was a machine of their own design for making ingots. Called the Electric Ingot Process, it has such features as: continuous melting and casting, progressive solidification, uniform analysis, minimum segregation, flexibility, low cost of molds per ton, and the ability to make small as well as relatively large ingots. The metal is completely protected from the atmosphere at all times, resulting in low melting losses, with almost all elements showing a 100 percent yield. And, no refractory linings are used, eliminating particle contamination.

According to Kellogg, the outstanding improvement as compared with the conventional cast steels is in the ductility; this is especially true in the central area of large sections such as gas-turbine wheels.

One of the basic raw materials in this process is the strip supplied in coils. For the iron-base alloys, for example, this strip usually is plain low-carbon rimmed steel. The strip usually is obtained in the cold-rolled condition in a gage and width suitable for forming into the desired size of electrode.

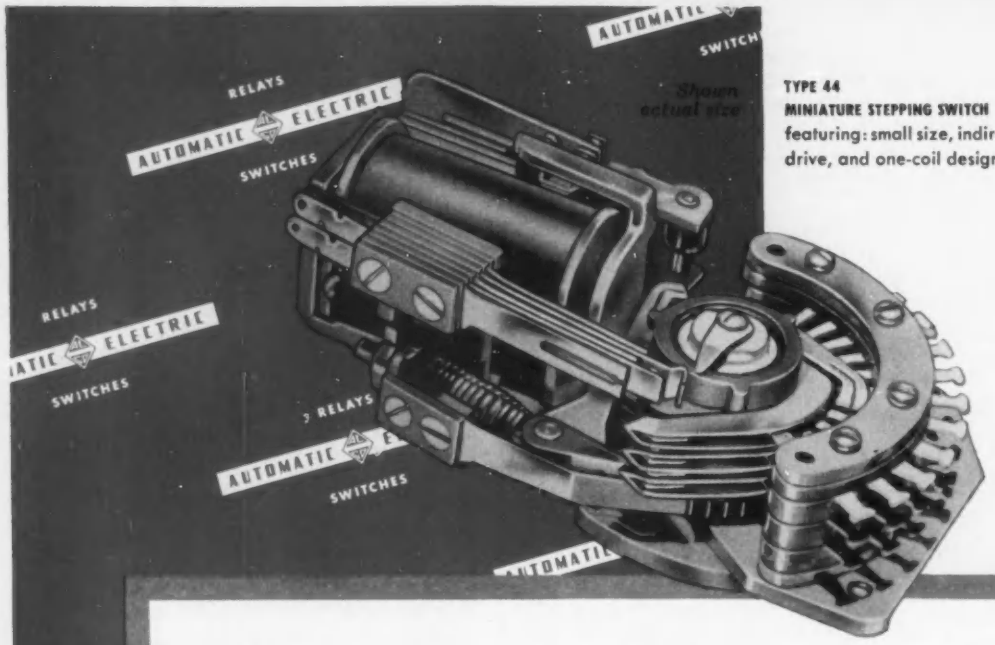
As in Fig. 1, the strip is passed through the tube forming machine K where it is formed into a cylindrical electrode G with edges butted. From here the electrode is passed through contact shoe H where it picks up the current for melting. It then extends into the mold where the current discharge F takes place below the slag blanket C.

The melting process is initiated by supplying a small quantity of crushed alloying materials, mixed in the proportion of the alloy to be melted, to the center of stool B. The mold and stool assembly is then raised until the end of electrode G contacts the pile of alloying materials. A supply of a dry synthetic flux is added to the mold and the machine is started.

As strip L is almost pure iron, it is necessary to add alloy materials to the melt to get the desired grade of steel. This addition is accomplished by the metering device M, shown above, at right. The metering devices are driven by the same motor that drives the tube forming machine, thus synchronizing it with the rate of electrode consumption.

Because of the fast solidification resulting from the use of the water-cooled mold coupled with the relatively slow melting rate, progressive solidification is obtained. There is a delay of a few minutes between the time of fusion of a part of the metal and the solidification of this same part. This time delay is a function of a depth of bath D. Once this depth has been established, it does not change, regardless of the length of the ingot. There is a definite balance between the rate of heat input and heat removal. This is one of the most important features of the process.

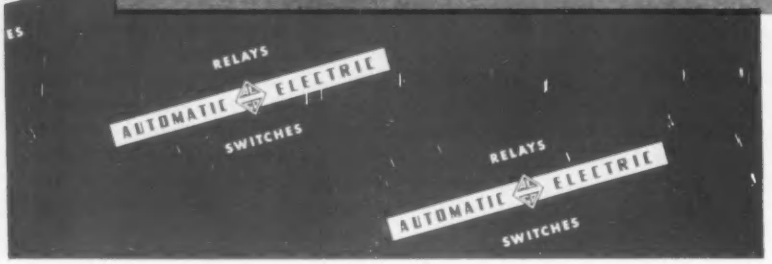
The process is flexible in that the grade of steel melted can be changed by the adjustment of the metering device. The size of the ingot being cast can also be changed.




TYPE 44
MINIATURE STEPPING SWITCH
featuring: small size, indirect drive, and one-coil design.

# *Well-Adjusted*

## for a long, active life




**200,000,000 operations, with little or no adjustment!**

*This rugged little stepping switch is racking up an outstanding service record in countless operations. It's Automatic Electric's Type 44 Miniature Stepping Switch, now going into more products than ever before!*

Its cost-reducing features are impressive. One-coil design eliminates a separate release coil. Indirect drive gives smooth, high-speed stepping. There's no wiper "double loading" or galloping. Here's the first compact, lightweight switch for 10-, 20- or 30-point operations. Use any dc voltage up to 110 (with rectifier, up to 115 volts, 60 cycles, ac).

To improve your products without raising costs, get the full details on Type 44 and Automatic Electric's *complete* line of stepping switches. Write to: Automatic Electric Sales Corporation, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. Offices in principal cities.

RELAYS SWITCHES

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

CHICAGO

# Calculating the Area of Curved Surfaces

VICTOR TATARINOV
Consulting Engineer,
Pilsen, Czechoslovakia

OFTEN IT IS NECESSARY to estimate the area of curved plates and sheets to establish the size and weight of material that will be required. The charts of Figs. 2-7 facilitate such calculations with an accuracy that is adequate for nearly all practical design purposes.

**1. Circular and Spherical Surfaces**

Using the symbols defined in Fig. 1(A), the length of arc $l$ of a circle of radius $r$ can be expressed as:

$$r = \frac{a^2 + l^2}{2l}$$

If the number of degrees in the arc is numerically equal to $2\alpha$, the value of $l$ becomes:

$$l = \frac{2\,\alpha\, r}{57.3}$$

The charts in Figs. 2 and 3 give the designer values of $r$ and $l$ when $a$ and $b$ are specified.

EXAMPLE 1. Determine the surface area of a motor casing having $a = 12$ in., $b = 4$ in., length $L = 30$ in.

SOLUTION:

Using the lefthand curve of Fig. 3, Line I indicates $l = 25.7$ in. Thus, the surface area $S = L \times l = 25.7 \times 30 = 771$ sq in.

EXAMPLE 2. Determine the surface area of a boiler drum cover that is a spherical segment 6 in. high. Diameter of drum $D = 28$ in.; thus $a = 0.50D = 14$ in.

SOLUTION:

From Line II in the lefthand curve in Fig. 4, $S = 5.1$ sq feet.

The flat sheet from which the cover can be stamped is also obtained from Fig. 3 as $R = 15.3$ in. The radius of the sphere, Line III in Fig. 2, $r = 19$ inches.

**2. Elliptical and Parabolic Surfaces**

The fundamental equation of an ellipse, symmetrical about the origin, is:

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

where $x$, $y$, $a$ and $b$ are defined in Fig. 1(C).

The perimeter of an ellipse can be expressed as:

$$P = \pi\,(a + b)\,k$$

where $k$ is a correction factor equal to

$$1 + \frac{1}{4}\,m^2 + \frac{1}{64}\,m^4 + \ldots$$

and $m = \dfrac{a - b}{a + b}$

The fundamental equation of a parabola, Fig. 1(D), is:

$$y^2 = 2px$$

At some point $u$, whose coordinates are $x$ and $y$, the length of arc is:

$$l = 0.5p\,[\sqrt{a(a+1)} + ln\,(\sqrt{a} + \sqrt{a+1})]$$

where

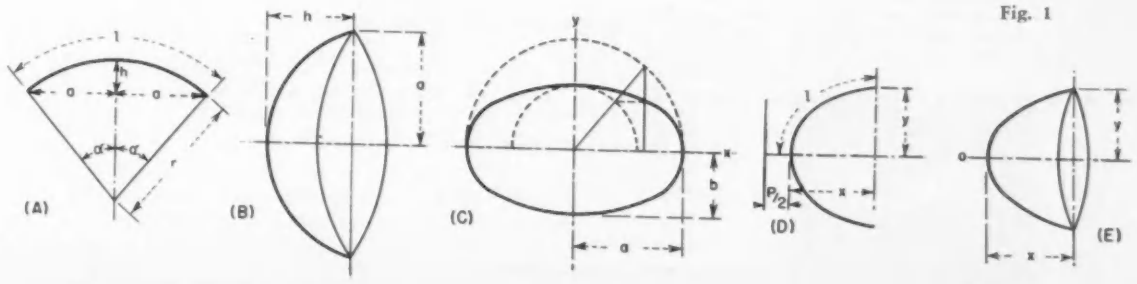
$$a = \frac{2x}{p}.$$

The surface area of a paraboloid of revolution is:

$$S = \frac{2}{3}\,\pi\,p^2\left[(a+1)^{3/2} - 1\right] = 2.09\left(\frac{y^2}{2x}\right)^2\left[\left(\frac{2x}{p} + 1\right)^{3/2} - 1\right]$$

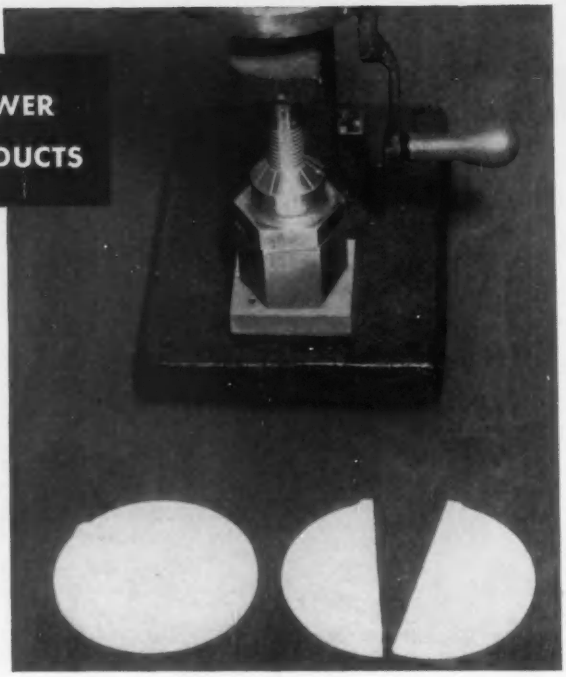
*(continued on page 203)*

Fig. 1



PUT SELLING POWER
INTO YOUR PRODUCTS

"Needle-Penetration" Toughness Tester consists of weighted needle and hand crank. Needle shown in raised position before being tripped to fall on test sample.



Comparison of discs made of Lustrex Hi-Test 88 (left) and general purpose styrene after needle penetration tests.

Descending needle shatters test disc made of general purpose styrene.

Falling needle *punctures* test disc of Lustrex Hi-Test 88 indicating the strong shock resistance, and excellent flexibility and elongation of this material.

**Punishing impact test points way to product quality . . . with** HI-TEST 88 LUSTREX Styrene Plastic

Consider what this dramatic demonstration of Lustrex Hi-Test 88 styrene can mean for your products. Now, at a time when retailers and consumers are becoming more and more insistent on improved product performance, Lustrex Hi-Test enables you to provide a competitive advantage with a stronger, tougher and more durable material.

Lustrex Hi-Test 88 styrene is *five times tougher* than general purpose material. In flexibility fatigue tests, Lustrex Hi-Test 88 demonstrates more flexibility than other styrene impact materials. Yet it sells at a price you can afford, to upgrade your regular product line for greater selling power.

Lustrex Hi-Test 88 has good appearance, good color stability, and excellent moldability. It has outstanding vacuum forming characteristics. Can be extruded or molded. Because it orients less (and thus has less variation in internal stress), it is highly recommended where lacquering is done.

For full information, mail the handy coupon below.

MONSANTO

SERVING INDUSTRY . . . WHICH SERVES MANKIND

MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2109
Springfield 2, Mass.
Please send me full information on Lustrex Hi-Test 88 styrene.

Name & Title _____

Company _____

Address _____

City, Zone, State _____

*(Continued from page 201)*

EXAMPLE 3. Determine the surface area of an elliptical tank for which $2a = 40$ in., $2b = 20$ in. and length $L = 100$ inches.

SOLUTION:

Line IV of Fig. 5 indicates $l = 97.5$ in. The surface area $S = l \times L = 9750$ sq in. $= 67.7$ sq ft.

EXAMPLE 4. Determine the surface area of a paraboloid of revolution forming the nose section of an airplane fuselage. Assume $x = 25$ in. and $y = 30$ inches.

SOLUTION: From Line V in Fig. 7, the surface area $S = 29.9$ sq ft. From the same curve, $R = 37$ in. is the radius of flat sheet that will be required.

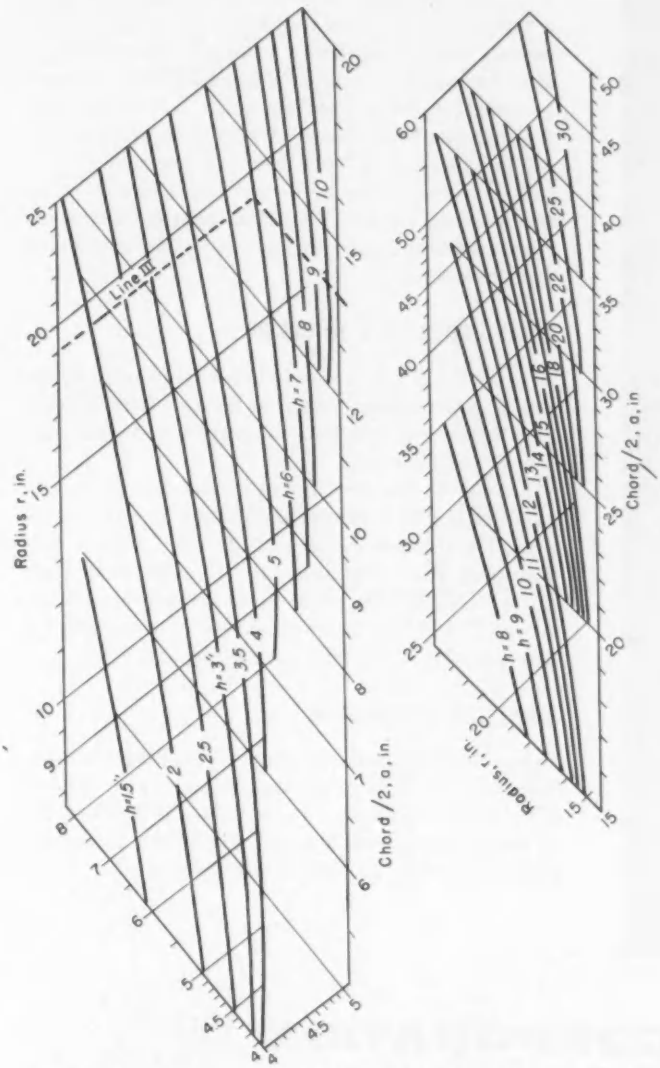



**Fig. 2** Relationship between radius, chord and chordal height of circular segments

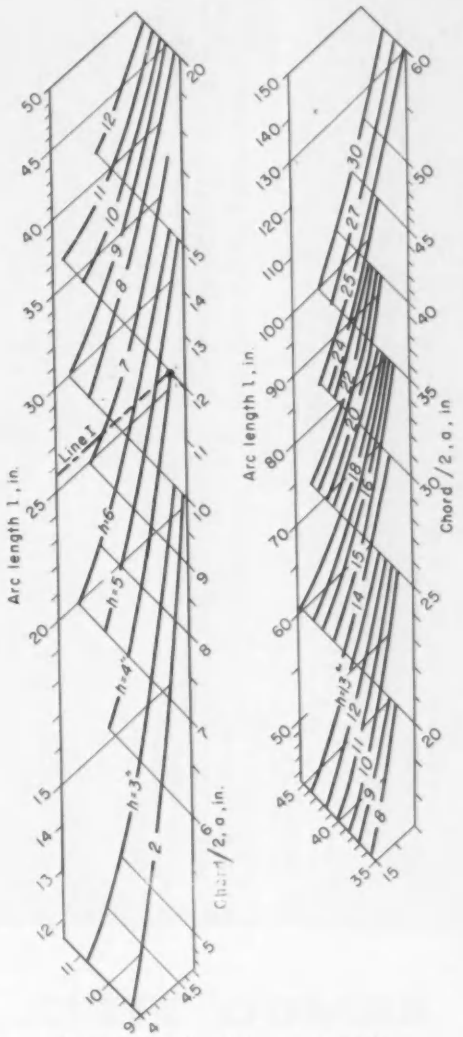
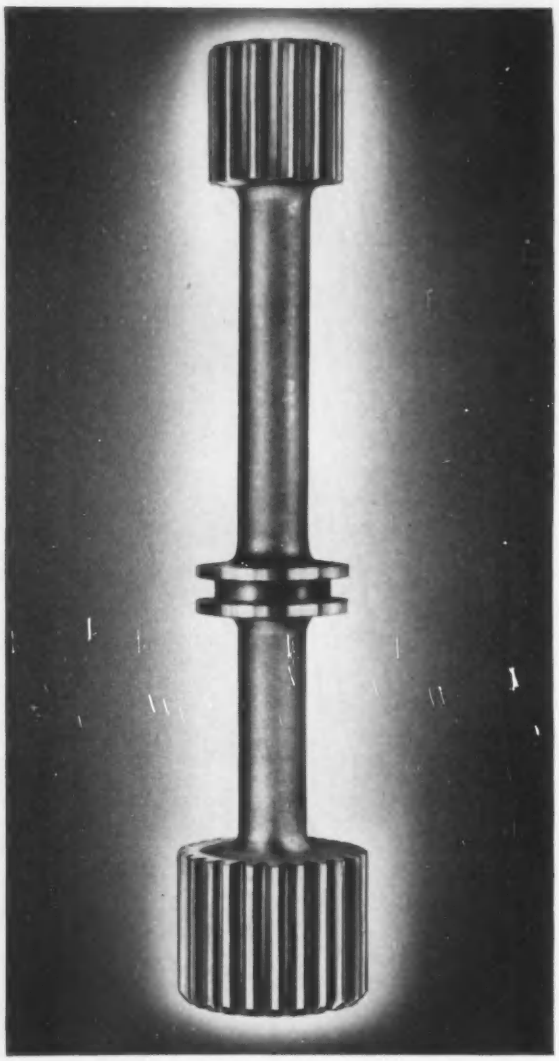



**Fig. 3** Arc length of circular segments

*(continued on page 205)*

# RESISTS FATIGUE 3 TIMES AS LONG AS RUNNER-UP IN TEST



Here's a case where Armco 17-4 PH Stainless Steel solved a fatigue problem in a vital hydraulic pump shaft for military aircraft use. Under accelerated fatigue tests the shaft made of Armco 17-4 PH lasted 30 hours. The next best metal in the identical test was a non-ferrous alloy. It lasted nine hours. Shafts of 4140 alloy steel and Type 440-C stainless steel lasted less than one hour.

Many other metals were tried but it took a special stainless steel, Armco 17-4 PH, to meet the mechanical requirements of rapidly changing loads, fast acceleration and deceleration.

### WHAT ARMCO 17-4 PH OFFERS

Armco 17-4 PH is a precipitation-hardening stainless steel of good corrosion resistance. It can be fully hardened after fabrication by holding at 850 to 900 degrees F for 1 hour and air cooling.

Because of the low-hardening temperatures, Armco 17-4 PH can be finish-machined in the annealed condition without allowance for scaling or distortion in heat treatment. Machining speeds are the same as for Type 410 (BHN 280-320), while in the hardened condition, Armco 17-4 PH can be machined at 60 per cent of Type 410 speeds. In both cases, finish is excellent.

### WRITE FOR INFORMATION

Armco 17-4 PH is produced in billets, bars and wire. Then too, there is the double heat-treatment precipitation-hardening grade known as Armco 17-7 PH. It is supplied in sheets, strip, plates, bars and wire. Write us for complete information on both of these grades.

**ARMCO STEEL CORPORATION**

4484 CURTIS STREET, MIDDLETOWN, OHIO

ARMCO®

SHEFFIELD STEEL • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

*(Continued from page 203)*

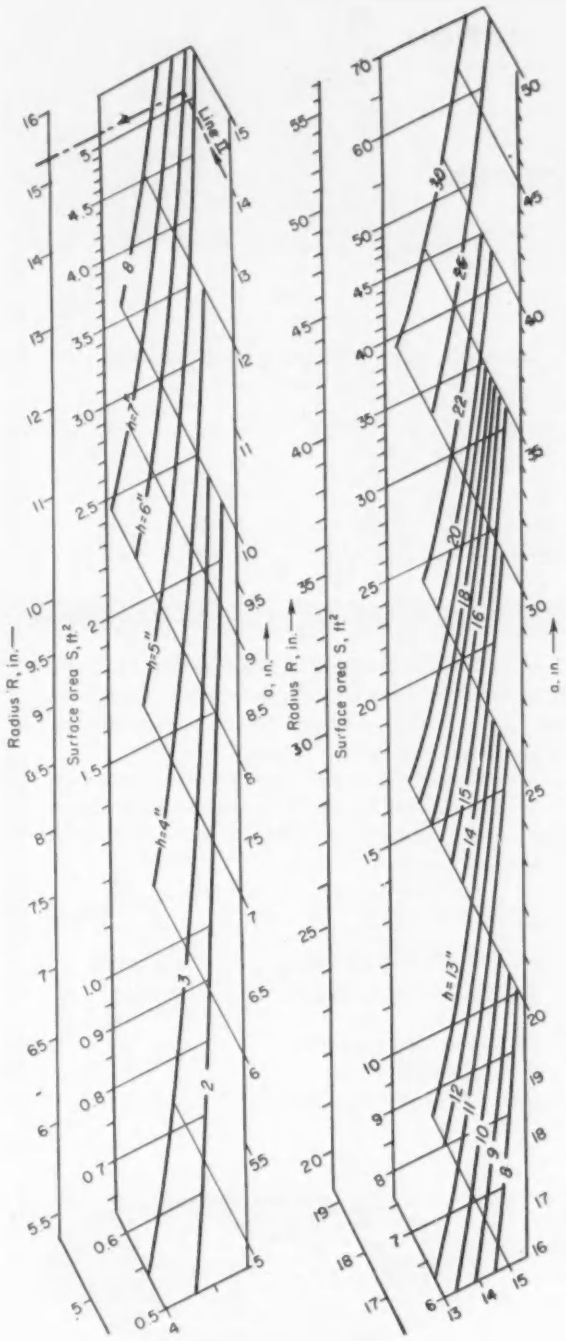



**Fig. 4**— Surface area of spherical segments

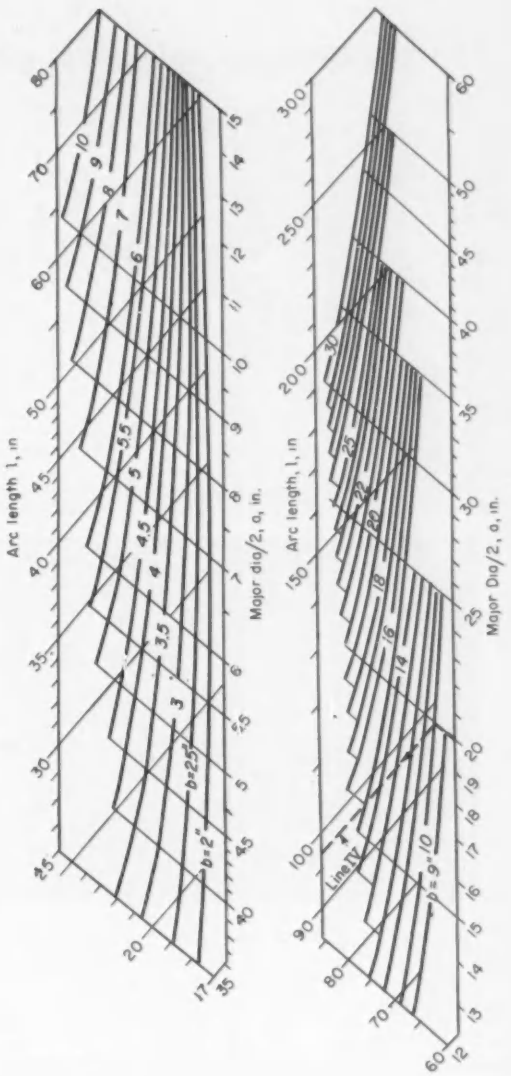


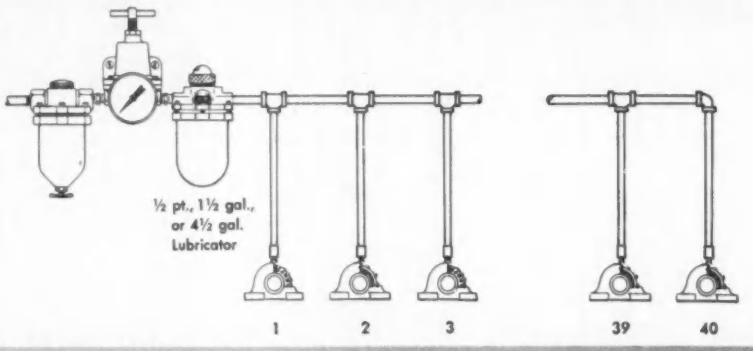

**Fig. 5**— Arc length of elliptical segments

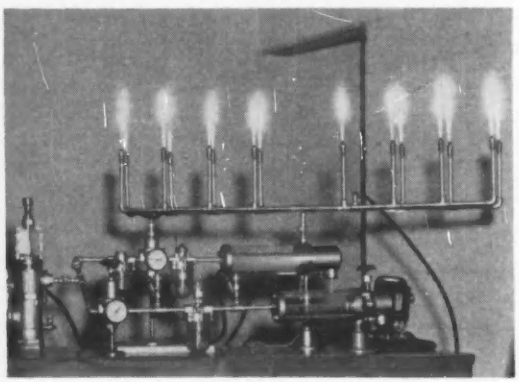
*(continued on page 207)*

tests prove

Norgren micro-fog lubricator

gives absolutely uniform lubrication thru 40 outlets for bearings, spindles, gear boxes



Special multi-outlet testing apparatus in Norgren research laboratory demonstrates uniform distribution of Micro-Fog

Two exclusive features of Norgren Micro-Fog Lubricator—constant oil level and metering of oil feed by an auxiliary air circuit—assure an exactly uniform and accurately regulated rate of oil feed.

Performance data prove that Micro-Fog gives complete lubrication after traveling thru more than 200 ft. of pipe—assures equal distribution of lubricant thru as many as 40 outlets.

**WRITE FOR NEW NORGREN BLUEPRINT MF-9**

**gives complete engineering data on application of Micro-Fog on bearings, gears, chains, etc.**

PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 26 YEARS

Valves • Filters • Regulators • Lubricators • Hose Assemblies

C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.

*(Continued from page 205)*

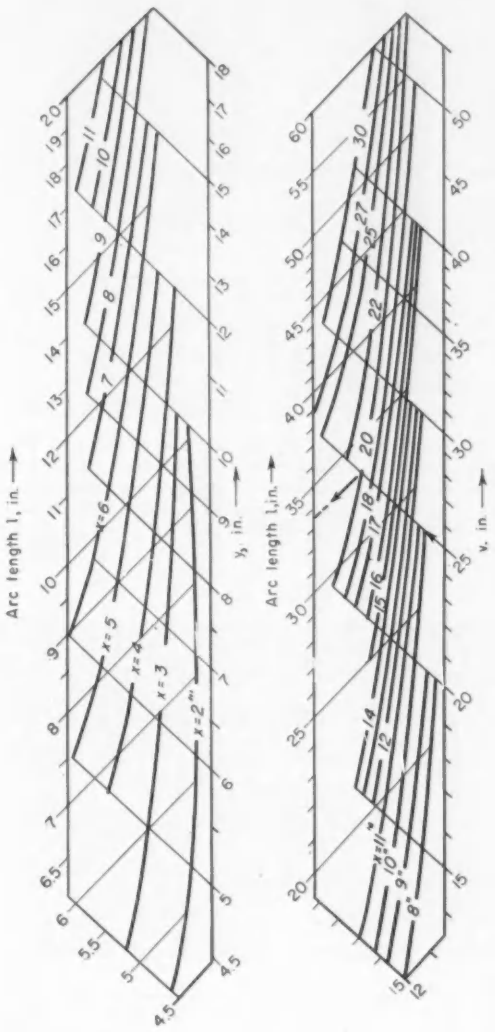



**Fig. 6**— Arc length of parabolic segments

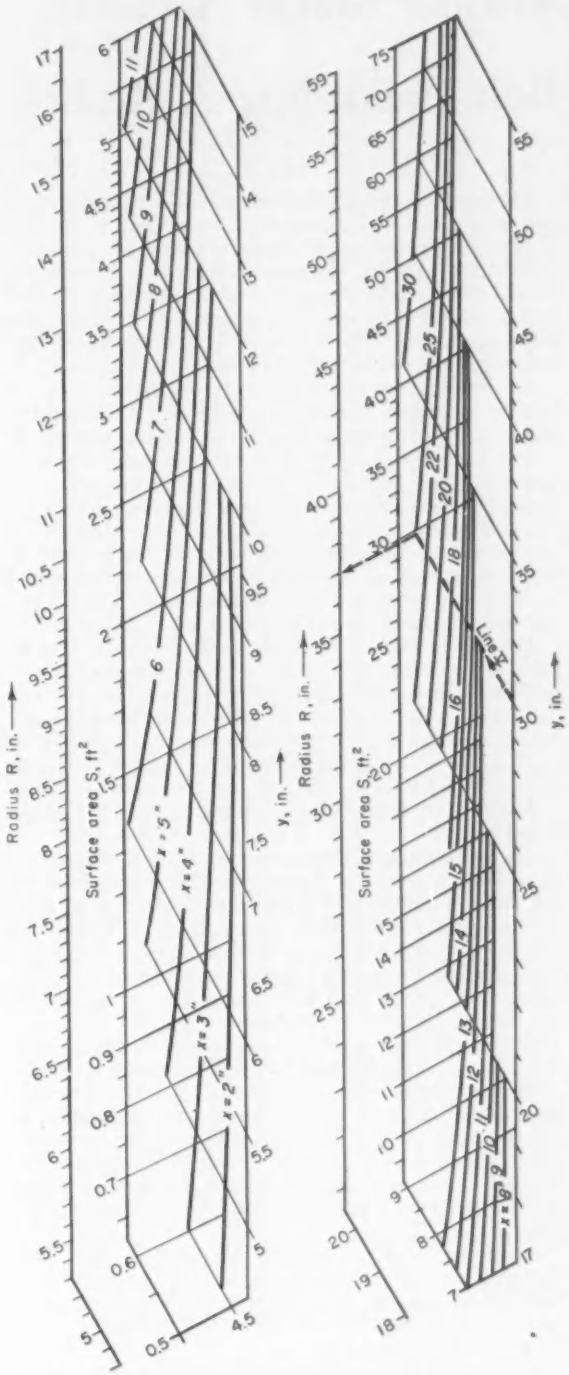



**Fig. 7**— Area of parabolic surfaces

# Washer Makes Accurate Bolt Preloading A Reality

As soon as licensing arrangements can be completed, a new washer that makes possible more accurate preloading of bolts used in aircraft assembly will be made generally available to industry. Exhaustive tests with the washer showed that it can be designed to assure an average tension preload of 80 percent of the desired bolt preload with slight deviations. This will result in a sharp increase in the fatigue life of the bolts, it is stated.

The washers are now being used on air transports to join the lower half of the nose section to the fuselage, to join wing and fuselage and for wing sections attachment.

Continued tightening of the nut compresses the inner ring until both rings bind. When the outer ring can no longer be moved, the desired preload has been reached.

The load at which the bind occurs can be controlled by choice of washer dimensions and the washer material.

During the tightening operation the operator "wiggles" the outer ring by means of a disposable handle. This handle may be straight or especially shaped for easy access purposes.

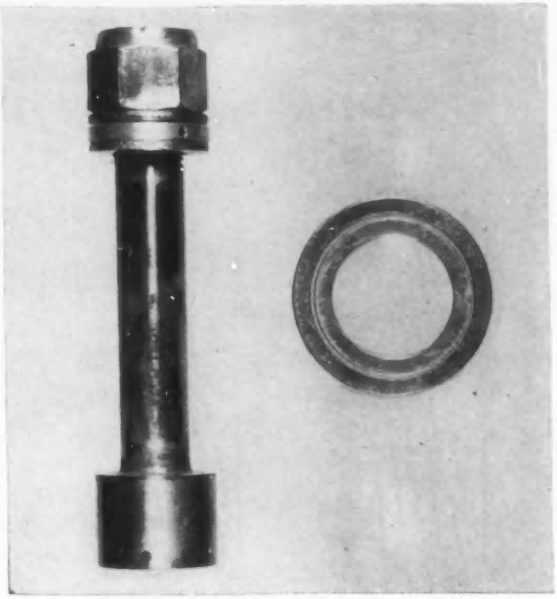
The conventional method of controlling the preload in bolts and screws is the "torque wrench" technique which produces inconsistent preloads in the fastener.

The reason for this fatigue life improvement is explained by the accompanying schematic drawing (at right) of a tension joint with a preloaded bolt (A). In (B) the shape of the joint has been modified for illustrative purposes, and in (C) the loaded bolt has been replaced by a spring under tension.

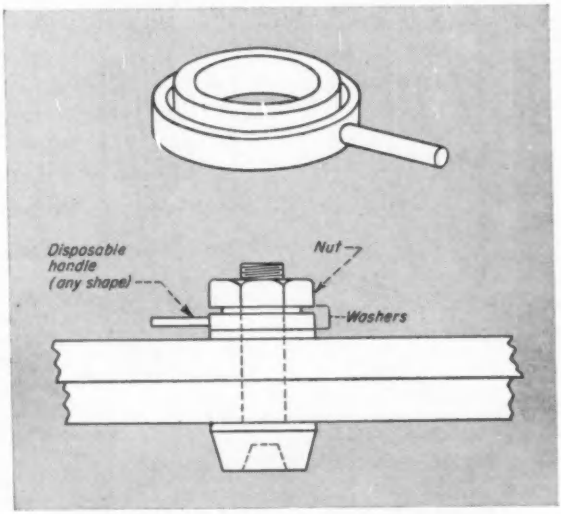
Analyzing the configuration shown in (C), when there is no joint load, (P = O) the two faying surfaces (F), are under a compressive load equal to the spring load. Assuming the frame is rigid, the length of the spring will not change until the faying surfaces begin to separate. Since the load in the spring cannot change unless its length changes, the spring load will remain constant as long as the faying surfaces remain closed.

As the joint load is progressively increased, the compressive load on the faying surfaces decreases correspondingly, while the spring load remains constant. Finally, as the load approaches the spring load the faying surface compression becomes zero. When (P) exceeds this load, the faying surfaces begin to separate and the spring load begins to rise. As long as the maximum joint load is less than the spring preload, fluctuations in the joint load will not cause fluctuations in spring load.

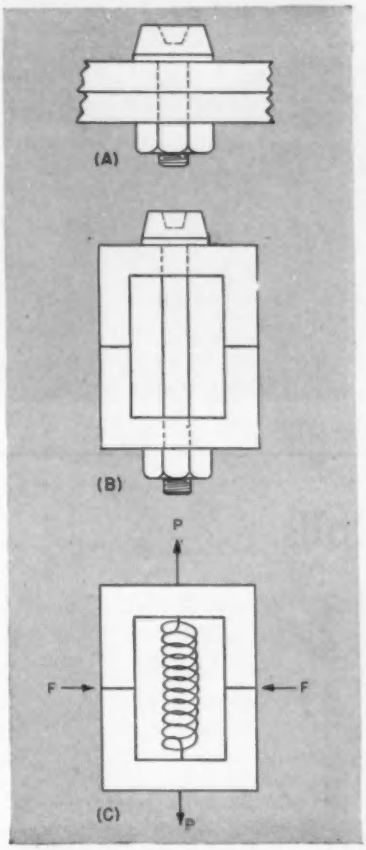
Replacing the mental image of (C) with the equivalent configuration in (A) we see that with a sufficiently high bolt preload, the joint load fluctuations will cause no corresponding fluctuations in bolt load. Since the life of a bolt subject to fluctuations in tensile load is determined by the magnitude and number of these fluctuations, a high preload will improve its life.



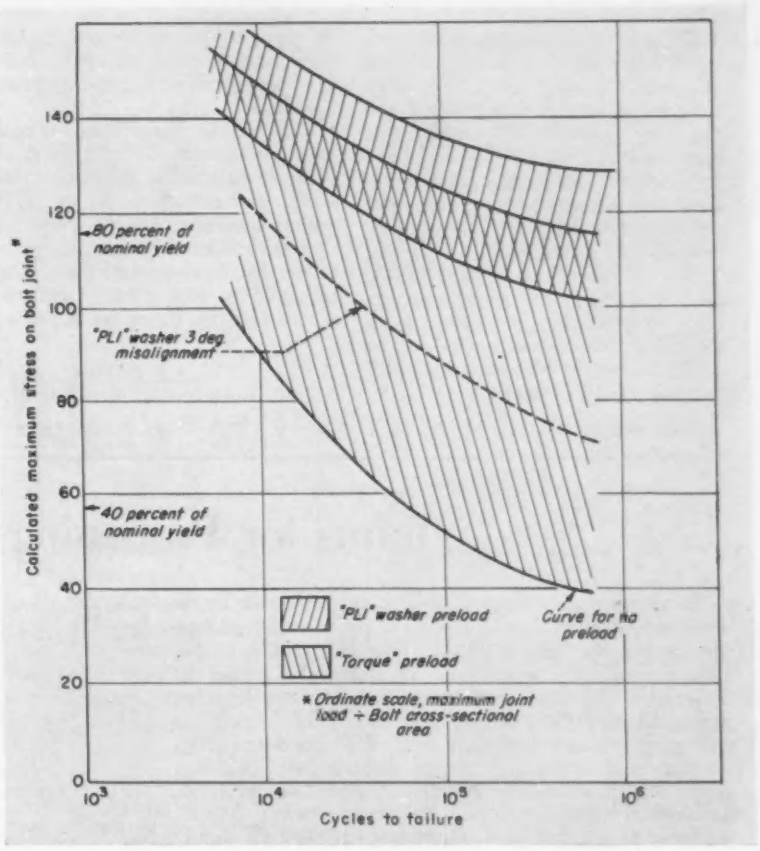
**TWO CONCENTRIC METAL RINGS** make up this new "PLI" or preload indicating washer. The thicker inner ring takes the load first when bolt is tightened. Continued tightening causes the outer ring to bind as desired preload is reached. The point at which this bind occurs can be controlled by choice of washer dimensions and materials.




**BOLT AND PRELOAD INDICATING WASHER** is shown here in assembly. Note disposable handle on outer indicator section of washer, used to test degree of tightening and, hence, preloading. A sharp increase in fatigue life of bolts preloaded in this way is reported.




IN (A) A PRELOADED BOLT is shown schematically. In (B), shape of bolt has been modified for illustrative purposes. In (C) loaded bolt is replaced with spring.




APPROXIMATE S-N SCATTER BAND based on 149 bolts (160-180,000 psi). Some of these bolts were preloaded for this test by "torque" technique and some by use of "PLI" washers to 70 to 90 percent of yield (preloads typical of new washers).
*Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, Calif.*

# Generates Time Delays of 1 to 1,000 Microseconds

A new time delay generator provides variable time delays ranging from 1 to 1,000 microseconds. Three delay ranges are provided, giving a full scale reading of 10 microseconds delay on the lowest range and progressing by decade steps to the highest range. A blocking oscillator output is provided.

The wide range of delays available, together with the accuracy of setting, is likely to make this unit especially useful in the radar, computer, and pulse technique field for measuring unknown delays, generating a delay for the simulation of radar range, providing delayed sweeps for synchroscopes, or measuring wave forms.

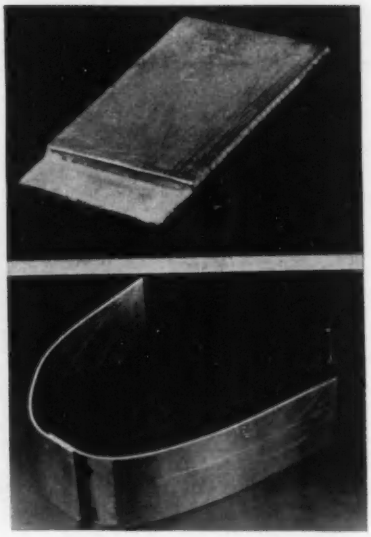
The instrument is said to be characterized by high linearity, accuracy, and freedom from jitter. The large clear dial facilitates setting, and the decade ranges prevent crowding of scales. Incremental delays as small as 10 millimicroseconds per division are available, with settings to fractions of divisions also being possible with this new equipment.

The unit is mounted in a louvered case with maximum overall dimensions of 7½-in. high x 7½-in. wide x 13-in. deep. The new time delay generating device weighs 20 lb.

*Rutherford Electronics Co., 3707 S. Robertson Blvd., Culver City, Calif.*

CONTINUED ON PAGE 210

# Adhesive Bonds Metal to Metal And Metal to Plastic



One of two new structural adhesives for bonding metal to metal and metal to plastic is said to provide high strength at normal temperatures and the other good flexibility at elevated temperatures. Originally developed for aircraft structural applications, these new formulations appear to offer widespread applicability to regular industrial production needs.

One of the formulations, M615, developed for normal temperature use, is said to yield shear strengths (under the USAF tensile shear method) up to 3500 psi with accompanying peel strength (NEMA method) up to 19 lb, plus exceptional impact strength. Top photo shows aluminum bonded to glass-reinforced, silicone-impregnated board.

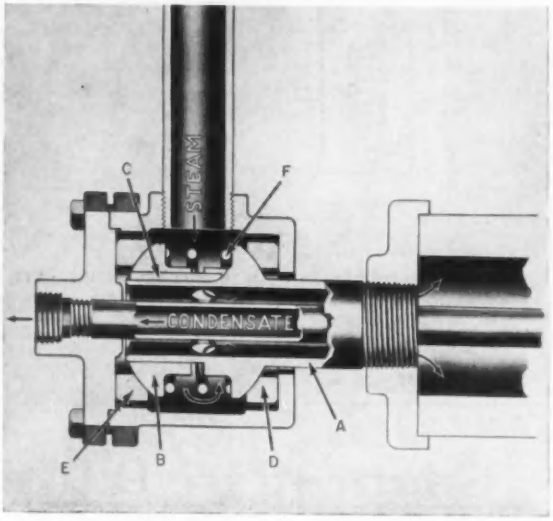
The second formulation provides shear strengths up to 3000 psi at 180 F, while maintaining exceptional flexibility. Bottom photo shows aluminum-to-aluminum bonded strips bent to a half-circle. This specimen maintained 1500 psi strength after being subjected to temperatures that were reported to be in excess of 300 F.

*Asbestos Corp., Dept. P, 225 Belleville Ave., Bloomfield, N. J.*

# Joints for Processing Rolls

These joints are designed for admitting steam or fluids into the rotating rolls and cylinders of paper, textile, rubber and similar processing machines. They are available in the through-flow type—which calls for location of a joint at each end of roll—or syphon type, which has both the inlet and outlet connections housed in the same joint.

The arrows show how steam enters the syphon-type joint through inlet in body. It passes through ports into the nipple and then into the roll or cylinder. Condensate is removed through the head. The rotating member consists primarily of just two parts: the nipple (A) and the thrust collar (B), which slides freely over the nipple but is keyed to it (C). Both of these parts have convex hemispherical surfaces as shown, which rotate against the matching concave surfaces of two special carbon graphite rings (D) and (E). The spring (F) maintains an initial seating pressure against these two rings, but the actual sealing force is the pressure within the joint, which forces the seal ring (D) against the nipple; the higher the pressure, the tighter the seal. The ring (E) serves as a bearing for the thrust collar.




*Johnson Corp., Three Rivers, Mich.*

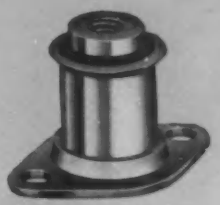
A NEW RELAY with high dielectric ceramic insulation and inter-contact capacitance on the order of 1.5 mmf is said to be especially applicable to circuitry where inter-contact capacitance losses are critical. It is available with a maximum of three movable and three fixed arms giving any allowable arrangement of Form A, B or C. Contacts are of pure palladium rated 1 amp, 28 v, dc or 115 v, 60-cycle ac, non-inductive load. Gold alloy contacts may be supplied on order to handle low-voltage, light-current loads. Maximum dimensions of open units are $\frac{3}{32}$ in. wide x $1\frac{1}{2}$ in. high x $1\frac{5}{16}$ in. Sealed units: $1\frac{1}{32}$ x $1\frac{3}{8}$ x $2\frac{3}{32}$ in. Potter & Brumfield, Princeton, Ind.

A NEWLY DESIGNED self-locking nut is said to eliminate lock washers. They are double chamfered and countersunk and may be assembled either side up for automatic hopper assembly. The new nuts are available in steel, brass and aluminum and in all machine screw sizes. Jacobson Mfg. Co., Inc., Kenilworth 9, N. J.

CONTINUED ON PAGE 212

# SILENTBLOC

## is a proven way to "stifle" the shakes



Shock mount to cushion and reduce magnitude of sudden shock.

Bearings and bushings for torque action and oscillating movements . . . no lubrication required.

Rolling joint type to dampen and isolate vibration, reduce noise transmission, cushion shock loads.

General Silentbloc mounts can do something about the universal plague of vibration, shock and noise in equipment ranging all the way from delicate instruments to heavy machinery.

Silentbloc mountings, bushings and bearings are being used today with outstanding success in automotive, refrigeration, industrial, aeronautical, marine, electrical, agricultural, household and dozens of other fields. These units can be custom designed and manufactured in any size and type.

For an engineered appraisal of your vibration problem send us the facts on your company letterhead. For a free design guide to vibration control fill out the coupon below.

"From Plans to Products in Plastics and Rubber"

THE GENERAL TIRE

*Industrial Products Division*

WABASH INDIANA

**The General Tire & Rubber Company**
**Industrial Products Division**
**Wabash, Indiana**

☐ Send free design guide to vibration control

☐ Have your representative contact us

Company_____ Name_____

Street_____ City_____ State_____

PE-8-54

MARKS MADE BY serrated interior of right angle adapter barrel can be clearly seen on aluminum conductor shown here. These indentations break through oxide film on surface and establish adequate electrical contact.

COMMON TOOLS such as a hammer or ordinary electrician's pliers are used to drive the new tin-plated copper adapters on aluminum cable. Straight type adapters are shown installed on double cable in right foreground. Right-angle model is in center, foreground.

# Aluminum and Copper Conductors Linked

A new connector now makes it possible to use aluminum and copper conductors interchangeably in equipment such as meter enclosures, enclosed electrical terminal connections and for exposed pole-line transformers, cutouts and capacitors. The new adapter is made in straight and right angle types for No. 4 and No. 2 stranded aluminum cable.

Standard copper-alloy connectors provided in electrical apparatus are designed for copper conductor and don't have the special characteristics required when aluminum is used. For example, aluminum has greater thermal expansion than copper; it is very ductile; it is covered with an oxide coating that must be penetrated to form a good electrical connection. Furthermore, a copper connector can produce galvanic corrosion of the aluminum conductor. The new adapter compensates for these factors, according to the manufacturer.

Made from a special tin-plated copper alloy, the adapter is designed to combine good electrical conductivity with springiness. It has a round barrel from which extends a smaller, split cylinder called a tang. The barrel fits on the cable and the tang is inserted under the equipment clamp. The slot that splits the tang extends well into the barrel forming the two legs.

When clamped, the adapter's legs are squeezed together like cantilever springs. This spring pressure is effective all around the aluminum cable surface and compensates for any expansion and contraction due to current overloads. Company engineers describe this as a "breathing effect."

Since the oxide film that forms on aluminum has high electrical resistance, cleaning action was built into the new connector. Its bore is slightly smaller than the cable diameter and is serrated with many sharp ridges, which break through the oxide film, providing numerous low-resistance electrical current paths. A factory-applied oxide-inhibiting compound seals the joint from air and moisture.

The adapter's copper-alloy construction protects the ductile aluminum cable from mechanical damage by electrical equipment clamps, while its heavy coat of tin plate resists galvanic corrosion.

The adapter is installed simply by driving it on the cable with a common tool such as pliers or hammer. Then, the adapter-cable assembly is inserted under the equipment clamp. As the clamping screw squeezes the adapter's legs together the serrated bore takes a firmer grip on the cable. This improves the electrical contact still further. Also, the spring pressure of the split tang locks it in place.

*Thomas & Betts Co., Elizabeth, N. J.*

**CORRECTION**

On page 230 of the June, 1954, *Product Engineering*, glass fiber insulation made by Gustin-Bacon Mfg. Co., 210 W. 10 St., Kansas City, Mo., was described as available, molded to shape, "in any size up to 8 x 10 in." This should have read, "up to 8 x 10 ft."

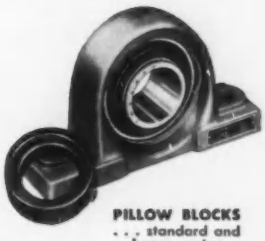
CONTINUED ON PAGE 214

*preference points on power transmission units*

# Not one but two GREASE PORTS!

If you select power transmission units with re-lubrication in mind, you'll appreciate the importance of the Fafnir two-grease-port design to dependable ball bearing performance. There is always one grease port in the bearings' outer ring that is never more than 90° from the lubrication fitting . . . and this fitting, incidentally, can be your own type because Fafnir provides standard pipe plugs.

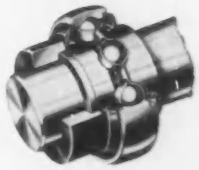
Point by point comparisons of design features, from the Fafnir-originated wide inner ring ball bearing with self-locking collar . . . easiest of all to install . . . to the frictionless Mechani-Seals . . . explains the steadily-growing preference for Fafnir Ball Bearing Power Transmission Units. For details, call your nearby Fafnir distributor. The Fafnir Bearing Company, New Britain, Conn.



**PILLOW BLOCKS**
. . . standard and heavy series

**FLANGE CARTRIDGES**
. . . standard and heavy series

**CYLINDRICAL CARTRIDGES**
. . . standard and heavy series



**WIDE INNER RING BALL BEARINGS**
. . . with Mechani-Seals

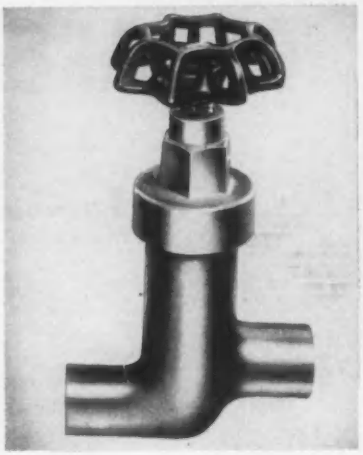
**FAFNIR**
**BALL BEARINGS**
MOST COMPLETE LINE IN AMERICA

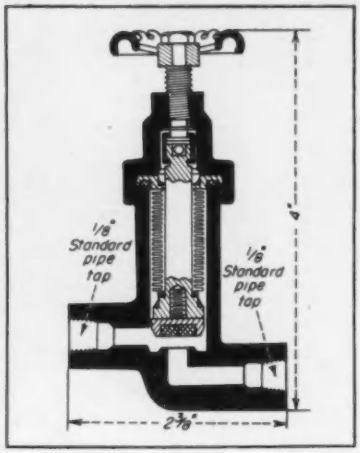
# Bellows-Type Packless Valve

A bellows-type valve in hand-operated or pneumatic-hydraulic models is recommended for —65 to 250F service, for high vacuum and high pressure systems, for the handling of volatile liquids and gases and corrosive fluids. The all-metalic construction of these valves eliminates the use of sliding or restrictive packings, insuring a positive leak-tight seal and minimizing wear and deterioration.

Then hand-operated valve features a ball joint construction in the handle which prevents torque from being transmitted to the bellows and valve stem. The valve is seated by a straight vertical thrust with no rotating motion.

The pneumatic-hydraulic model is especially well suited for multiple manifold arrangements and for remotely operated valves. Standard models are rated for pressures up to 150 psi and, with minor modifications, can be adapted for much higher pressures. They are useful where prolonged exposure to temperature extremes has adverse effects on conventional packing materials. In the handling of volatile liquids and gases, the metallic sealing of the valve stem reduces hazards of fire and explosion and corrosive attack. Bellows of corrosion-resistant metals such as stainless steel and Monel can be furnished on special order by the customer.






The pneumatic-hydraulic operated model operates on line pressures of 10 to 150 psi. The valve seat is spring loaded to insure positive opening action when actuating pressure is released. Inlet and outlet fittings are $\frac{1}{8}$ in., female pipe tap on both valves.

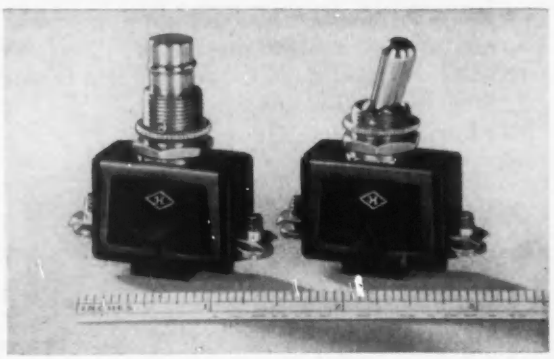
*Clifford Mfg. Co., Grove St., Waltham 54, Mass.*

# Small Switches with High Current Capacity

A new line of small switches with what is described as an unusually high current carrying capacity for their size has been developed and is now being marketed. They are designed for incorporation in portable tools, home workshop power tools, light machine tools, air conditioners, vacuum cleaners, panel boards, power amplifiers and similar applications where space is at a premium but a resistive load up to 25 amp or a motor up to 2 hp must be controlled.

Both toggle and push button types are included. In both, the switch base measures only $\frac{9}{64}$ x $\frac{21}{32}$ x $1\frac{3}{16}$ in., yet it is available with ratings up to $1\frac{1}{2}$ hp at 120 v, 2 hp at 240 v, and up to 25 amp at 120 and 240 v (ac only). Special ratings up to 30 amp will be available on special order.

*Hart Mfg. Co., 110 Bartholomew Ave., Hartford, Conn.*



TWO NEW MODELS of an all-bronze reverse flushing filter for 1 in. 2 in. pipe connections are said to remove all suspended foreign matter and deliver clean, clear liquids. Filter elements which need never be replaced are made of sintered bronze, microporous porcelain or porous alundum. A range of filtering grades are available, for handling particles from 100 down to 0.5 micron. Flow rate is in proportion to pipe carrying capacity with negligible pressure drop. Reverse flushing is accomplished by means of a push-pull plunger and requires only a few seconds. An outside media may be used for reverse flushing. Homefilter Co., N. Brookfield, Mass.

CONTINUED ON PAGE 216

# are you fighting space?

*connect with cannon!*

Are you looking for complete electrical circuit dependability in a very, very small space?

If so, you should use Cannon carefully engineered miniature and sub-miniature multi-contact connectors. In ½ or ⅓ the usual space, they give you up to 50 contacts, the same number as a standard connector, and still retain all the factors of utility, reliability, and mechanical strength found in Cannon's standard size connectors. They are very rugged, easy mating, unusually versatile, neat and compact.

**Miniatures—Maximum Dimensions Only 1" x 2"!**

high-dielectric insulation. Rack, panel, chassis types . . . receptacles and plugs, standard, pressurized, or hermetically sealed . . . box, wall, or cord mountings . . . for audio, control, and instrument use. A and U sub-miniatures have steel shells; CPA and K miniatures have die-cast shells. Five-ampere gold-plated contacts are found in all miniatures and sub-miniatures, excepting U receptacles, which have steel contacts. Larger contacts having higher current ratings, and co-ax contacts, are in process of development.

**Sub-Miniatures—Only 2-6/32" x 29/64"!**

*first in\connectors*

**CANNON PLUGS**

**Write for Cannon Miniature and Sub-Miniature Bulletins**

Please refer to Dept. 106

**CANNON ELECTRIC COMPANY, 3209 Humboldt Street, Los Angeles 31, California.**

**Factories in Los Angeles, East Haven; Toronto, Canada; London, England.**

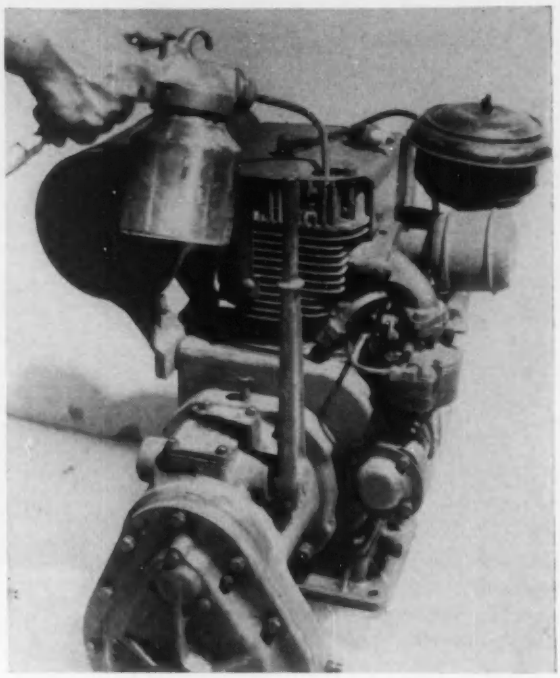
**Representatives and distributors in all principal cities at your service.**

# Protection Against Rust and Corrosion

Quicker yet longer rust prevention is said to be provided by a crystalline amine nitrite compound, a white powder about as fine as talcum which will not clog a flocking gun (see illustration) and can easily be applied with a squeeze bottle, a salt shaker or any similar device. Where spraying or dusting of the VPI is impractical, the powder may be dissolved in alcohol and applied in solution. Other methods of application are currently being tested.

VPI-250 does not have to be applied directly to the surface it is to protect. If a quantity of the powder is simply dropped into an enclosed space, its vapors will penetrate even into hard-to-reach areas and condense on all surfaces. The minute crystalline film produced does not have to be removed from equipment before it is placed into operation. Only small quantities of the material are required for complete protection in shipment or storage, or between successive processing steps. Fourth, small items, such as tools, can be removed from a protected atmosphere, used, and then replaced without the need for any additional rust-preventive measures.

This white powder has been effective in preventing corrosion under high humidity in aircraft and other internal combustion engines, in tools and dies, sand blasted parts, continuous strip steel, automotive parts, anti-friction bearings, stamping and forgings, sheet metal components and parts to be plated, machine tools and like applications.



*Shell Oil Co., 50 W 50 St., New York 20, N. Y.*

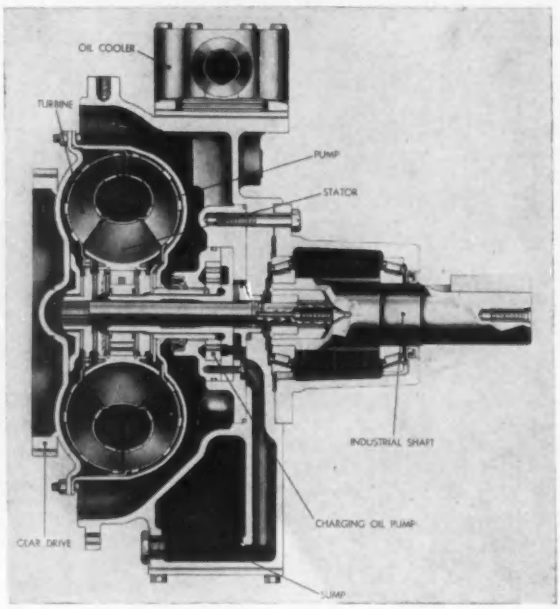
# Torque Converters for Lower Hp Engines

Torque converters meeting the requirements of heavy-duty operation now are available which can be used with either gasoline or diesel engines in the 40 to 150 hp range. The new units have a wide range of application, including road rollers, cranes, shovels, end loaders, tractors and ditchers.

It is expected that the new converter will provide the same flexibility of power transmission which has now become standard in the diesel engine field. Because it has been designed as a standard package for use throughout its field, this new series can be offered within the price range of the automotive type. In addition, many features such as the combination of hydraulic torque multiplication with fluid coupling are standard in the converter at no extra cost.

The unit is designed for simplified flexible installation because integral with the converter are oil system, charging oil pump, oil cooler, oil sump and gear drive. Installation can be made on any SAE standard power takeoff flywheel.

However, available with the basic converter are a wide variety of optional equipment, including front disconnect clutches and adapters, rear disconnect clutch adapters, automotive type flanges, industrial shafts and governor drives.

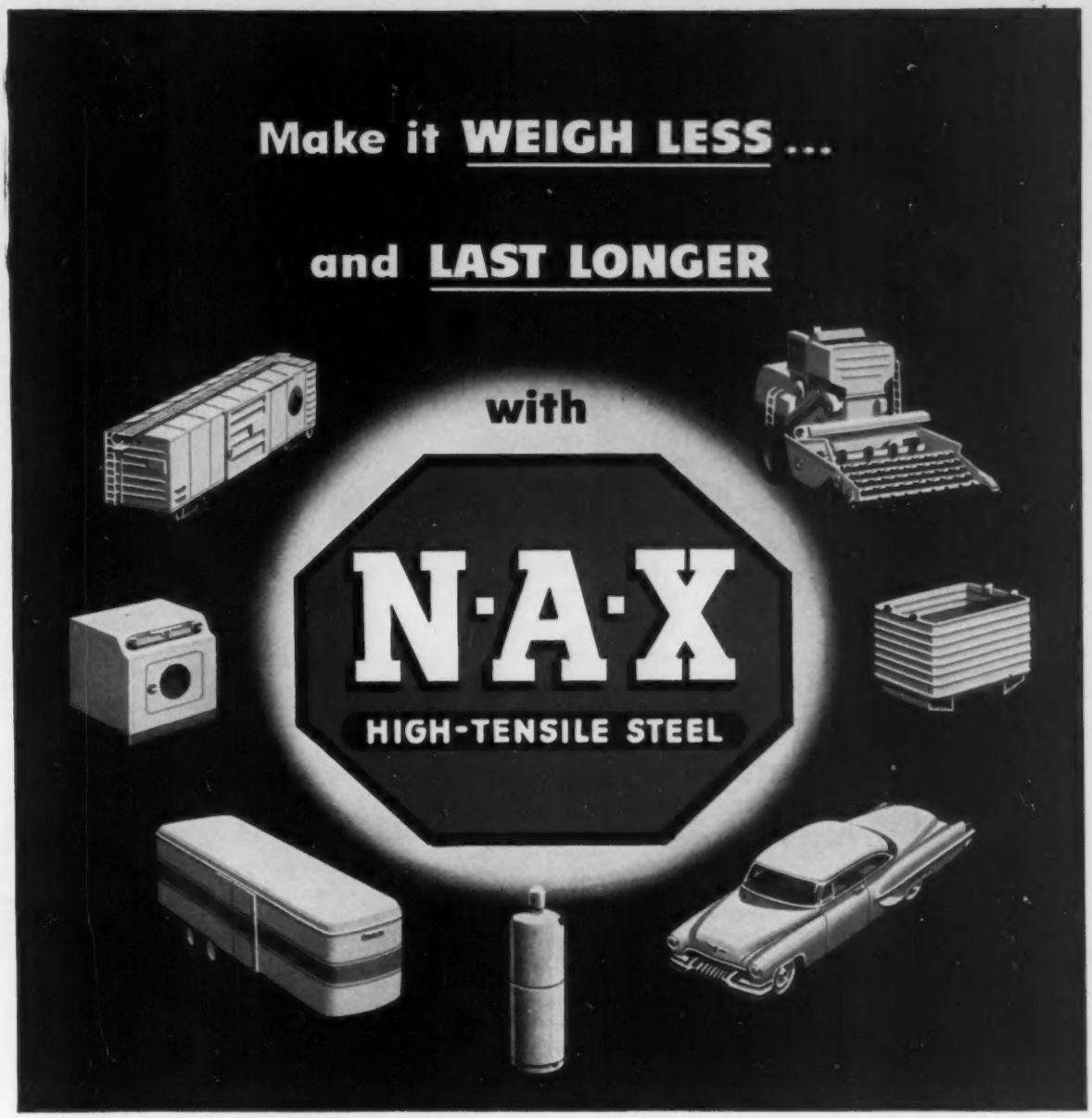



*Allison, Div. of General Motors Corp., Indianapolis 6, Ind*

CONTINUED ON PAGE 218

# Make it WEIGH LESS ...

## and LAST LONGER




You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

It is 50% stronger than mild steel.
It is considerably more resistant to corrosion.
It has greater paint adhesion with less undercoat corrosion.
It has high fatigue life with great toughness.
It has greater resistance to abrasion or wear.
It is readily and easily welded by any process.
It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel—it can be cold formed as readily into the most difficult shaped stamping.

Sound like something for you? Ask for full facts and think of N-A-X HIGH-TENSILE when you re-design.

**GREAT LAKES STEEL CORPORATION**

N-A-X Alloy Division — Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

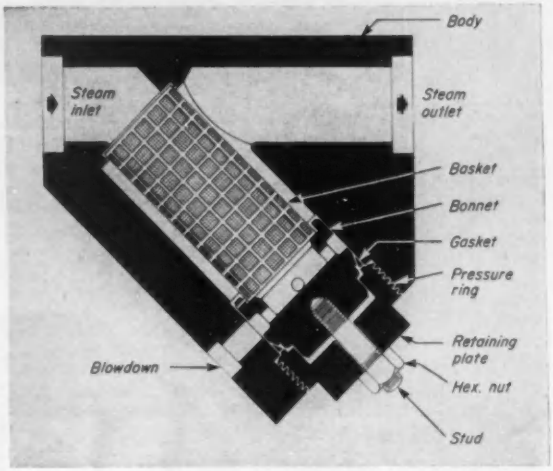
# Steam Line Strainer Has Pressure Seal, Forged Body

A new, compact strainer is said to be capable of filtering dirt, scale and other foreign matter from steam and boiler lines where feed pressures are above 900 lb. The device is enclosed in a forged steel or forged alloy body and has a new "pressure seal" bonnet construction.

Besides making a pressure leak improbable, this bonnet design eliminates the excessive bulkiness of a flanged, bolted cover which, at higher temperatures and pressures, necessitates the use of large studs and nuts.

The base metal used in the new strainer's gaskets meets rigid specifications of physical conditions and dimensional tolerances. A special coating is applied to the gasket to provide a soft surface which will flow into irregularities in the body bore and cover. The gasket is tapered to a sharp angle to provide proper linear circumferential expansion even for small diameter joints.

Also to further compactness, the blow-down connection has been brought through the side of the strainer wall. This design feature means that no piping need be broken when removing the cover and strainer basket from the body for maintenance, checking or replacement. This factor is particularly advantageous at high pressures and temperatures, where pipe joints are usually welded.




*Schutte and Koerting Company, Dept. V-A, Cornwells Heights, Bucks County, Pa.*

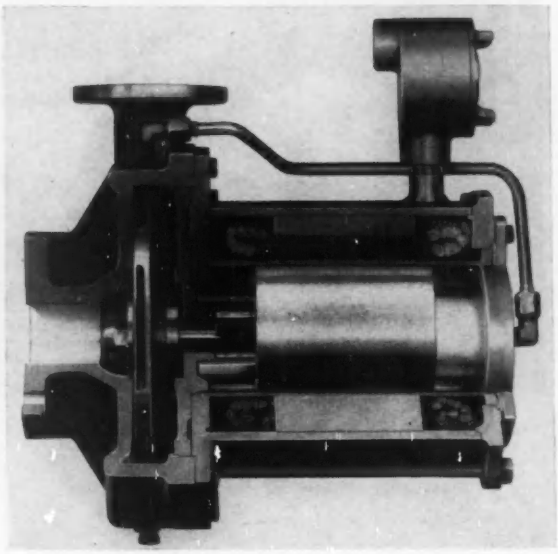
# Pump Guaranteed Against Leaks

A seal-less centrifugal pump that provides guaranteed leak-proof service has a welded type of construction that allows field dismantling and reassembly with no loss in these leak-proof qualities. "O" rings, used in earlier models, have been completely eliminated.

The company reports that the new pump has already been placed in service on applications where it handles materials ranging from butylacetate to titanium tetrachloride, and which include pumping hot sulfite liquor, hydrocyanic acid and molten sulfur, as well as many other hard-to-handle fluids.

It is reported that users report great satisfaction with the pump, experiencing no hazardous or expensive leakage or contamination of fluids that are customarily handled by this new equipment.

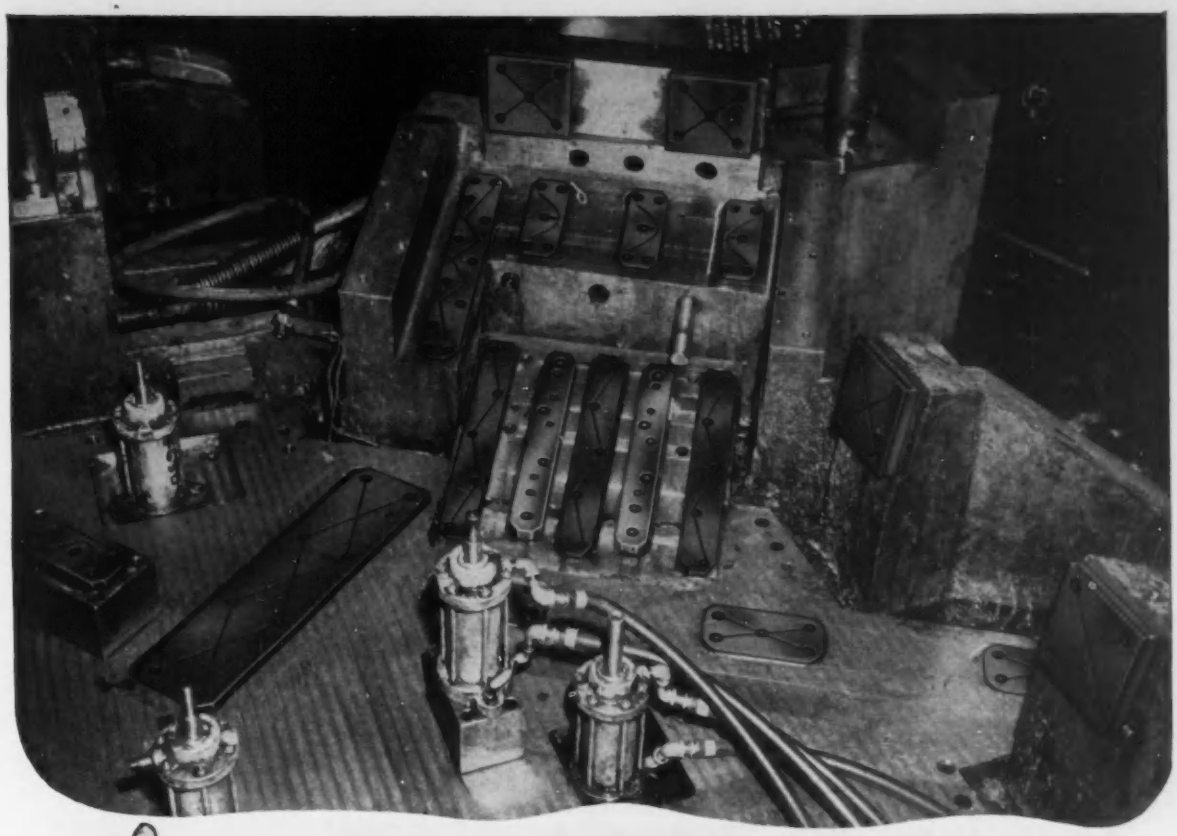
*Chempump Corp., Station R, 1300 E. Mermaid Lane, Philadelphia, Pa.*



A NEW POCKET-SIZE THICKNESS GAUGE measures non-magnetic protective and decorative coatings on ferrous metal bases with an accuracy of ±5 percent ±0.0001 in., weighs 6 oz. and incorporates a locking device, permitting the accurate reading of the scale after measuring an inaccessible area where the scale cannot be seen. The device relies upon a specially engineered permanent magnet for its power. Ferro Corp., Cleveland, Ohio.

AN ALLOY STEEL SLING HOOK, drop forged and heat treated, has an I-beam type design which is said to assure additional strength. A large eye accommodates shackle pins and wire rope thimbles. Extra area above the eye reduces wear at this vital point. The new hook is manufactured for $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$, 1 and $1\frac{1}{8}$ in. chain sizes. Weight ranges from $\frac{1}{2}$ to $4\frac{1}{2}$ lb. S. G. Taylor Chain Co., Hammond, Ind.

CONTINUED ON PAGE 220



## . . . long wearing, economical OK aluminum bronze wear plates

**Practically every important automobile manufacturer now uses OK aluminum bronze wear plates on body dies.**

By a unique clading process, long-wearing aluminum bronze is bonded to a machinable steel base. Cost is drastically lower when compared to solid cast bronze plates. A finer quality bearing surface is obtained, resulting in longer life. When fitting is required to suit die, steel backing of plate is easily machinable, and no difficulty is encountered drilling or counter boring through bronze surface. OK aluminum bronze plates are applicable wherever a die has a sliding or cam action. A large selection of sizes of OK aluminum bronze plates is *carried in stock* . . . finished ground, flat and parallel . . . ready to ship. Simply send your drawings or sketches to our engineering department.

*Manufacturers for the metalworking industry of:*
**SLITTER KNIVES • SHEAR BLADES • BRONZE WAYS ROTARY SHEAR KNIVES • HARDENED SPACERS • BALL RACES • HARDENED WAYS • WEAR STRIPS • GIBS**

**Dept. 12-B**

**THE OHIO KNIFE CO.**

CINCINNATI 23, OHIO

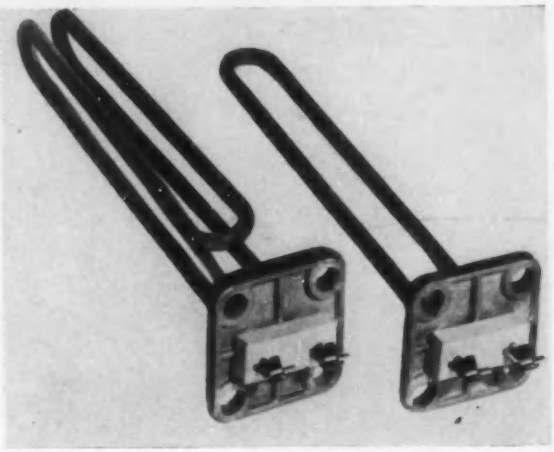
# Flange-Type Immersion Heaters

Single and double flange-type heaters have been added to an established immersion heater line, designed to operate on either a-c or d-c circuits at 115 or 230 v. They can be used in water baths, cleaning tanks, humidifiers, quench tanks, stills, sterilizers and similar equipment.

Offering a high watt density, the heaters are formed by bending a tubular unit into hairpin shape, the ends of which are brazed into a flange. A silicone seal and porcelain insulator are incorporated at the heater's terminal ends as a protective measure against vapors and liquids, and to provide electrical insulation. Terminal connectors are welded to low-resistance cold terminals which are attached to the resistance wire.

Suitable for maximum working pressures up to 125 psi, the heaters are engineered to meet low-pressure boiler specifications of ASME. Shipping weights are approximately $1\frac{3}{4}$ to $2\frac{1}{4}$ lb, depending on the model.

*General Electric Co., 1 River Rd., Schenectady 5, N. Y.*

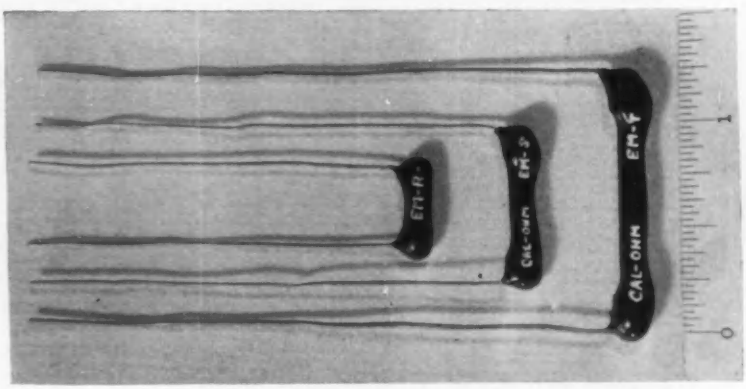


# Encapsulated Miniature Resistors

A new line of wire wound resistors of the encapsulated miniature type are being manufactured in accordance with MIL-R-93. Ranging in size from $\frac{7}{16}$ x $\frac{1}{4}$ in. to $1\frac{1}{4}$ x $\frac{1}{4}$ in., these resistors are available in capacities from 10 to 30,000 ohms. Higher resistances are available on special order.

Tolerances range from 1 to 0.01 percent. Other features include a low temperature coefficient of 0.00002 per degree centigrade and low thermal emf. These units are desirable in transistor use and digital computers.

*Eastman Pacific Co., 2320 E. 8 St., Los Angeles 21, Calif.*




# Flow Meter Causes No Pressure Drop

A liquid flow meter said to be based on a new principle measures water and aqueous solutions, acids and other corrosive liquids, slurries, emulsions, opaque liquids, liquids containing solids in suspension as well as molten salts and liquid metals.

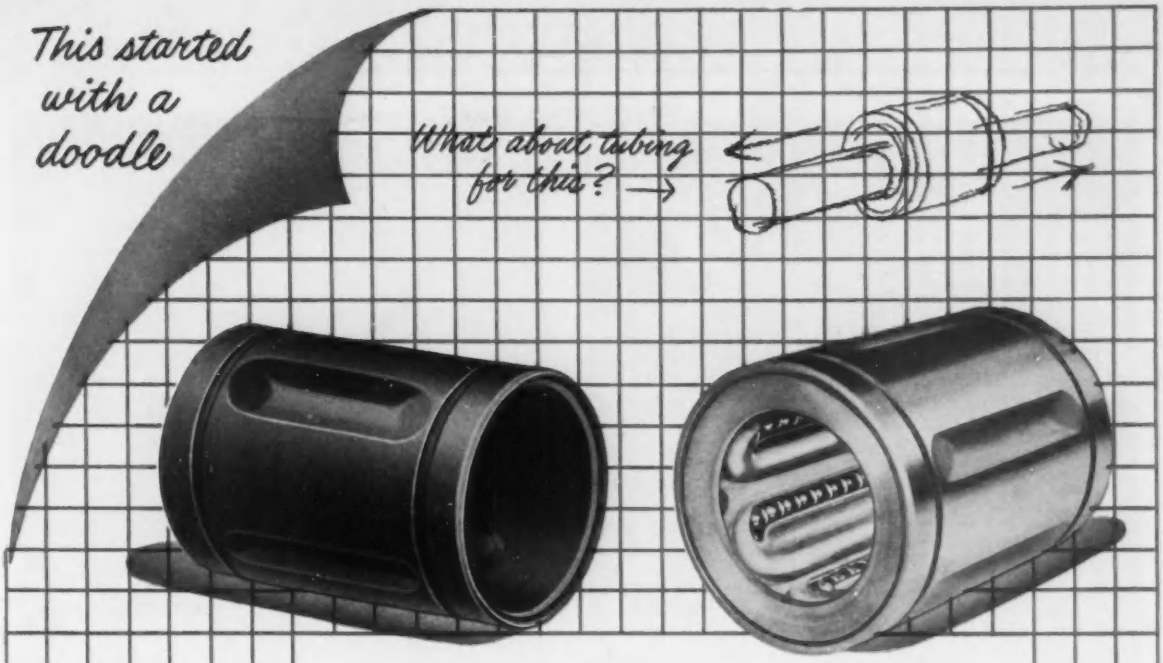
The metering element consists of an enclosed magnet, stainless steel tube with "Teflon" liner and attached electrodes, which are connected to the indicator or recorder remotely installed at any desired location. There are no moving parts. The metering element cannot be clogged since there is no constriction. Pressure drop through the metering element is no more than that of an equivalent length of pipe.

The limit of accuracy is rated at 1 percent of the full-scale reading, but under appropriate conditions an accuracy of $\frac{1}{2}$ percent can be obtained. This accuracy is not affected by changes in liquid viscosity, density, fluctuations of line voltage, temperature, or by transition from laminar to turbulent flow. The instrument scale is linear.

The meter is available in six sizes, ranging from $\frac{1}{2}$ to 2 in. High flow rates are possible with no restriction of the rate of flow. The capacity is limited only by the pipe size. The new device can be used to indicate quantity of fluid (the volume delivered) to indicate rate of flow, to record rate of flow or to accomplish a combination of these functions.

*Bowser, Inc., Fort Wayne, Ind*

CONTINUED ON PAGE 222




## Precision Tubing for Precision Jobs

Tubing tolerance is a big "must" on this job. Thomson Industries, Manhasset, N.Y., insists on it. Otherwise, manufacturing BALL BUSHINGS (ball bearings for linear motion) would have been even tougher than it was.

Part of the problem was the tubing to house the bearings and the raceway. Those bearings are very tough on tubing . . . especially at the contact points.

Other requirements were: good surface conditions; good dimensional control, both I.D. and O.D.; uniform wall thickness; uniform concentricity; and uniformity from a metallurgical standpoint to stand heat treating.

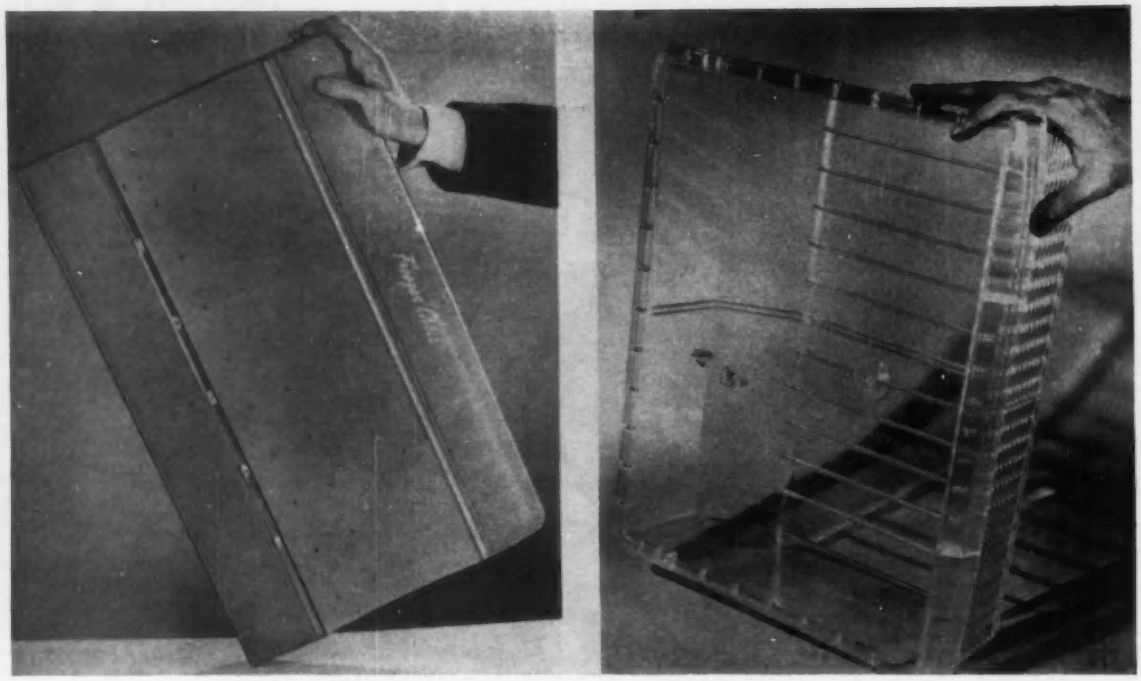
And, equally important, economy. By using ELECTRUNITE Tubing, Thomson Industries eliminates a grinding operation. That helps keep costs down.

The tubing that has all these advantages is Republic ELECTRUNITE, a *precision* mechanical tubing for applications like this. You can get it in carbon or stainless analyses. And Republic engineers will be glad to help you use it, profitably, in whatever products you make. Call your nearest Republic Sales Office or write to:

**REPUBLIC STEEL CORPORATION**
*Steel and Tubes Division*
222 East 131st Street, Cleveland 8, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

**REPUBLIC ELECTRUNITE TUBING**

REPUBLIC STEEL



# Three Improved Plastic Molding Materials

A versatile new general-purpose styrene plastic combines higher plasticity with faster set-up to increase and improve production of molded parts. SMD-3500 embodies the qualities of all previous styrenes and can be used on all types of injection molders.

In field tests, the new compound set up as much as 25 percent faster than previously used materials. Higher plasticity enables it to flow easily even through pinpoint gates and dispersion nozzles to produce parts relatively free from strains and weld lines. With the same molding cycle as used for the previous materials, a frozen food chest door required less pressure and resulted in substantial reduction in strains which permitted effective back painting (top left photo).

The molding cycle for a 36-oz refrigerator crisper pan was cut 25 percent with the new general-purpose styrene (top right photo). It filled out corners of the 19 x 14 x 5½-in. tray more evenly than the previous material, remaining free from distortion and satisfying the molder's strain test.

More or larger cavities can be filled with faster-flowing SMD-3500 in the same cycle, used for less versatile general-purpose styrenes. For example, six instead of four thin-walled tubes 5 x 1⅜ in. dia were molded at one time using the same molding cycle. This general-purpose styrene crystal has a high degree of clarity and both purity and uniformity of the colors are maintained by enclosed production processes under rigid control.

An acrylonitrile styrene plastic and a brown version of a recently introduced phenolic were announced at the same time as the above mentioned styrene compound. The acrylonitnile is RMD-4001, and it is high in clarity, offers wide color possibilities, has good flow properties and fast set-up.

Containing no volatile or fugitive plasticizers, the acrylonitrile-styrene combination is useful for many household and industrial applications where straight polystyrene would show crazing. It can be molded to close tolerances in thick and thin sections and in large areas without voids, bubbles or sink marks.

Averaging 11,700 psi tensile and 15,700 psi flexural strength, RMD-4001 survives drop tests proving its value for tumblers, cups and packaging uses. It is dimensionally stable through temperature changes from —40 to 190 F. Immersed for three hours in water kept at 190 F, 12-oz tumblers molded of the new material developed no measurable distortion.

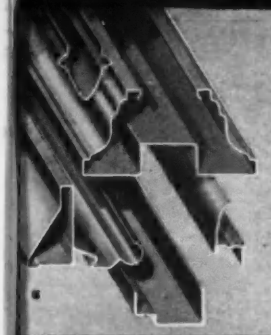
The brown version of a relatively new, multi-purpose, fast-curing phenolic molding plastic, of special interest to molders of electrical items, is known as BMG-5000 Brown 15.

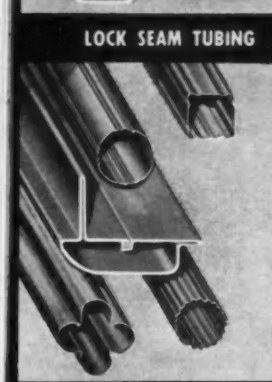
These properties include a wide molding latitude and faster curing time in excellent balance, permitting the new phenolic material to be molded by compression, transfer and plunger methods. With high rigidity at molding temperatures and at hot discharge from the mold, this compound maintains critical dimensions.

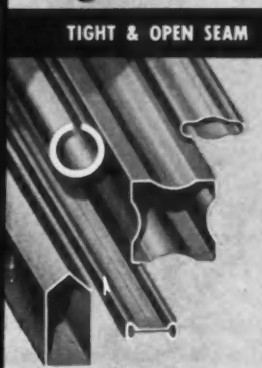
The versatility of this new material enables molders to reduce costs by storing fewer different compounds for varying requirements, by stepping up rate of production, and by producing more pieces to the pound.

*Bakelite Co., 260 Madison Ave., New York 16, N. Y.*

CONTINUED ON PAGE 224

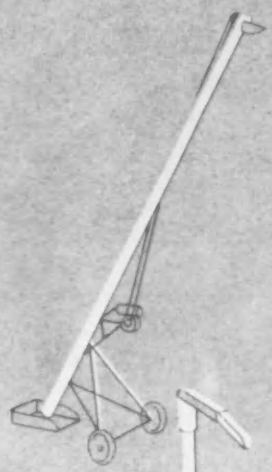


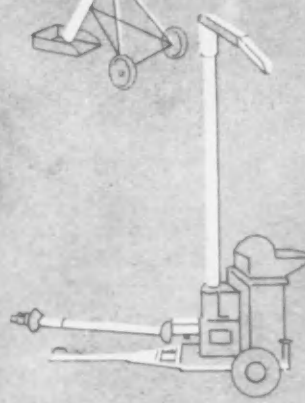


# *Van Huffel cold formed metal shapes and tubing simplify design and cut production costs for the makers of*

# farm equipment





**No matter what you make that farmers use, chances are Van Huffel Cold Formed Metal Shapes and Tubing can help you make it faster, cheaper and better.**

***Faster*** **because cold formed parts require very little or no machining; parts come to you shaped, cut, punched, or bent to your specifications.**

***Cheaper*** **because of the high strength-to-weight ratio you can, in many cases, use lighter gauges, or smaller sizes in place of solid metals. Parts are uniform in thickness, free from scale, and ready to paint.**

***Better*** **because of the wider latitude in choice of materials, design possibilities and fabrication methods. Shapes and tubing can be produced in Cold Rolled, Hot Rolled and High Tensile Steels. Van Huffel cold forms strip metals 1/2" to 33" wide; regular and irregular shapes in .018 to .312 gauge; tubing from 3/16" to 6" in diameter in any lengths.**

***Write today for free portfolio of cost reducing ideas that have taken shape in the farm equipment field.***

# Van Huffel

**TUBE CORPORATION · WARREN, OHIO**

***Where ideas take shape for makers of farm equipment***

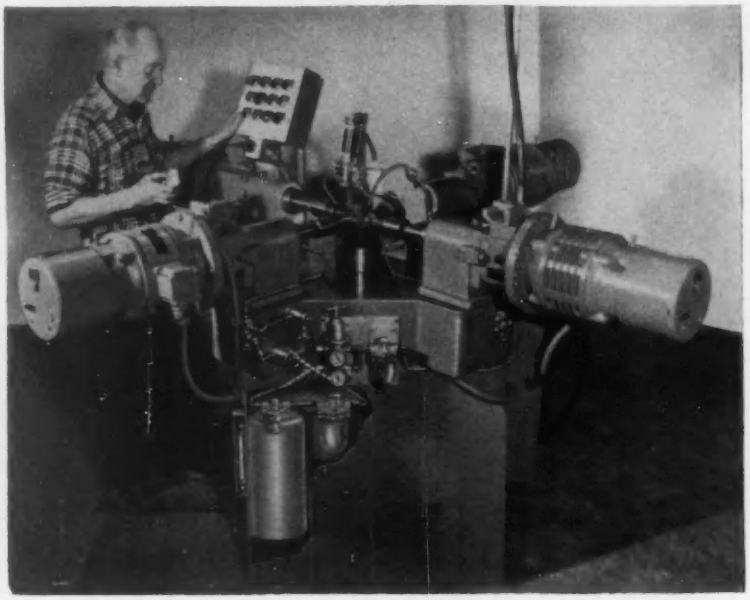
# Spray System Removes Heat Faster

A new spray system, expected to provide more complete and efficient utilization of coolants, cutting oils and drawing compounds, is said to permit more flexibility in application. This is because the oil-fog or aerosol used can be directed at the work area from any direction and to as many points as necessary.

It is believed that it is the finely divided spray, presenting greater amounts of surface area of the particles of oil or coolant, that effects the more rapid withdrawal of heat from the work area. The resulting lower tool temperature improves tool life.

Much smaller quantities of lubricants are required when using this application technique. Now available as an accessory, it is expected that the system will be designed as a built-in unit.

*C. A. Norgren Co., 3428 S. Elati St., Englewood, Calif.*



# Flexible Bushings Accommodate Different Sized Shafts

Roller chain flexible couplings designed to connect two shafts or a motor directly to a machine come in five sizes. They will compensate for dissimilar or undersized shafts, slight misalignment and radial thrust. They are stocked with bores ranging from $\frac{3}{8}$ to 2 in. and power ratings from fractional to 200 hp.

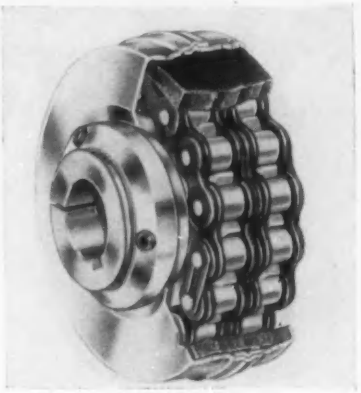
The coupling consists of two hardened steel sprockets, a strand of double roller chain, two bushings and a snap-on aluminum cover complete with oil retaining felt.

To assemble sprockets with bushings suitable to shaft diameters, bushings are positioned on shaft. A strand of double roller chain couples the sprockets together and the cover is snapped together over the assembly. To disassemble, cover is snapped off, chain uncoupled and bushing screws removed in each sprocket half.

Since bushings are interchangeable, no reboring alterations are required and all couplings are supplied from stock complete with keyways and set screws.

In addition, bushings can be used with the company's regular sprockets.

*Cullman Wheel Co., 1344 Altgeld St., Chicago, Ill.*



A STAINLESS STEEL METAL POWDER called "Stain-Alloy" which can be used by fabricators of gears, television cores, self-lubricated bearings, welding alloys, metallic paint, bushings, porous metal filters, small mechanical, electronic and electrical parts has increased resistance to intergranular corrosion of the sintered compact. A bright, free-flowing powder, all particles of which pass through 150 mesh, approximately 60 percent is stated to be finer than 325 mesh. This powder is substantially free from surface oxidation. It is moldable at compacting pressures of 30 to 50 tons per sq in. Effective sintering is obtained at 2100 F with normal sintering times. Alloy Metal Powders, Inc., 238 Eagle St., Brooklyn 22, N. Y.

ELEVEN SIZES are being offered in a new line of industrial accumulators of the piston type. Bore sizes (or shell inside diameters) are $1\frac{1}{2}$, 4, and 7 in. Lengths vary from $9\frac{3}{8}$ to 40 in. Oil volume capacities range from 10 to 1155 cu in. Operating pressure rating is 3000 psi. Industrial Hydraulics Div., The Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

CONTINUED ON PAGE 226

DOW CORNING CORPORATION

# Silicone News

No. 8 of a series • FOR DESIGN ENGINEERS

## Double Speed of Electropunch Impact Hammer with Silicone Class H Electrical Insulation

When one or more steps of a production operation are speeded up, the rate of the other phases must also be increased or they become prohibitively expensive.

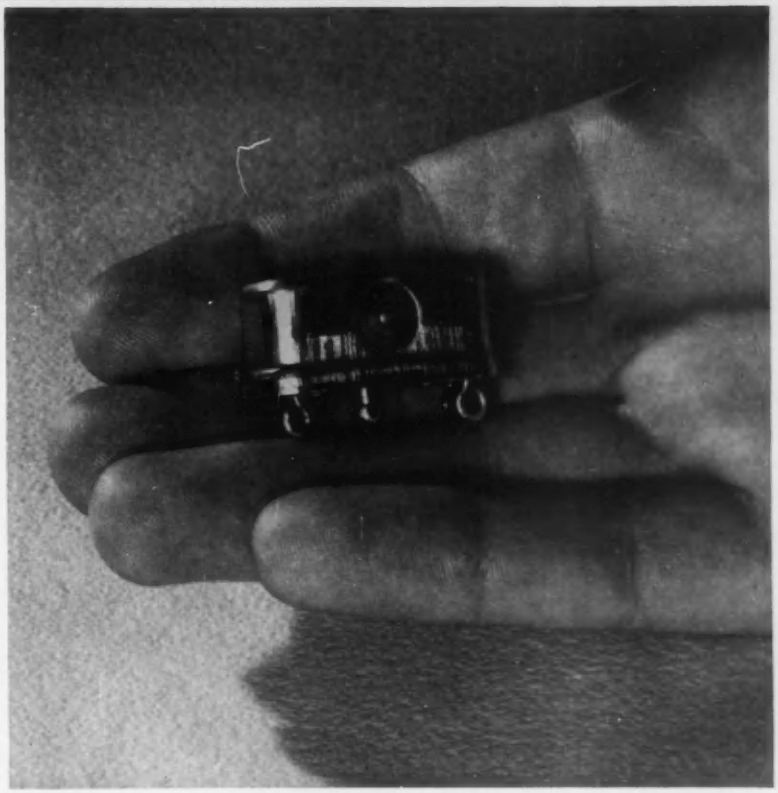
That's why Black & Webster, Inc. of Newton, Mass., changed to Dow Corning silicone (Class H) electrical insulation for their Electropunch impact hammers. Designed to deliver controlled, lightning fast blows for stamping, riveting, marking or staking, the original Electropunch hammer utilized a Class A or B 115-volt solenoid to deliver 60 blows of up to 3500 pounds each per minute.

As production rates crept upward, Black & Webster engineers realized the speed of the hammers must also be stepped up. An increase in power was the logical solution, but space limitations ruled out the use of larger solenoids. They then investigated Class H insulation which provides up to 50% more power per pound than the less heat resistant organic insulating materials. Class H, they found, enabled them to uprate the solenoid without increasing size or changing design. Five years ago they began specifying Class H for the solenoids of all their high speed punch equipment.

Electropunch hammers now deliver from 100 to 120 blows per minute at the same 3500 pound impact without overheating. For short bursts they will deliver as high as 180 blows per minute. Power consumption is only 1 KWH per 111,000 blows. Average life of the solenoids, under full power, is between two and three million blows.

That's typical of the "design-ability" of Class H insulation made with Dow Corning silicones. Adaptable to any electrical equipment and costing only slightly more than the next best class of insulation, it can be used to increase the power-per-pound ratio or to extend the life of electrical machinery over ten times.

No. 67



## Miniature Snap-Switch Sealed with Silastic Has Longer Life and Greater Reliability

A Silastic* diaphragm has enabled Haydon Switch, Inc., of Waterbury, Connecticut, to produce a hermetically sealed snap-action switch that weighs only about half an ounce and operates with less than half the effort required by standard "aircraft quality" switches.

The Silastic diaphragm remains so flexible that the operating force on the actuator need not exceed 32 ounces even at —90 F. Fatigue problems and subsequent unreliability associated with metal diaphragms are eliminated. Operational life in the range of a million cycles is far in excess of the best metal diaphragms or bellows.

Accelerated permeability tests indicate that the Silastic diaphragm maintains an effective hermetic seal for more than 10 years. Internal pressures up to 100 psi have failed to produce leakage or rupture, and no change in the diaphragms has been observed even after 72 hours' immersion in salt, fresh or soda water, or in automotive or AN-0-6 aircraft oil.

* T.M. REG. U.S. PAT. OFF.

(continued pg. 2)

DOW CORNING CORPORATION

# Silicone News

## DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .

"Developments In Silicones", a recent article from INDUSTRIAL LABORATORIES, describes several completely new silicone materials and recent improvements in a variety of standard silicone products. Included among the products discussed are magnet wire enamels, laminating resins, defoamers, textile finishes, a leather water repellent, nontoxic low compression set rubber and expansible resins. *No. 71*

∇

Recently announced Dow Corning 400 Gum, a truly stable and uniform silicone polymer, enables compounders and fabricators to produce a wide variety of silicone rubbers. Data sheet lists properties of 400 Gum and suggests recipes for compounding silicone rubbers to meet special requirements. *No. 72*

∇

"Silicones In Cosmetics." A recently published data sheet describes the use of Dow Corning 200 Fluid and Dow Corning 555 Fluid in cosmetological, dermatological and pharmacological preparations. Includes formulae, compatibility data and lists a useful bibliography. *No. 73*

∇

Dow Corning 6 Compound, a grease-like, non-hardening, rust preventative for ferrous alloy metal parts in delicate mechanisms and fine instruments, provides excellent protection during long time, indoor or outdoor storage. *No. 74*

∇

Dow Corning 55 Pneumatic Grease provides dynamic lubrication between rubber and parts in pneumatic systems; meets Specification MIL-L-4343A. Serviceable over a wide temperature range, and oxidation resistant, it shows superior lubricity over other silicone greases with certain metal combinations. *No. 75*

∇

New RTV SILASTIC, silicone rubber that vulcanizes and cures at room temperatures, is attracting unusual attention. Useful in design and engineering applications where the remarkable stability characteristics of silicone rubber are desirable, but where high curing temperatures cannot be attained or tolerated. *No. 76*

Dow Corning Corporation, Dept. R1-20, Midland, Michigan

Please send me: 67 68 69 70 71 72 73 74 75 76

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ___ STATE _____

## New Silicone Fluid Shows Promise In Wide Variety of Applications

A new silicone fluid which is remarkably compatible with organic materials has been developed by a team of our research and product development engineers. Identified as Dow Corning 555 Fluid, it is water white, odorless and easily diluted with such materials as lanolin, beeswax, mineral oil and 95% ethanol.

Primarily designed as an easily blended, non-separating functional ingredient for cosmetics and ointments, Dow Corning 555 also shows considerable promise as a release agent for specialized applications, as an additive for paints and petroleum products, and as a plasticizer for certain rubbers, resins and plastics.

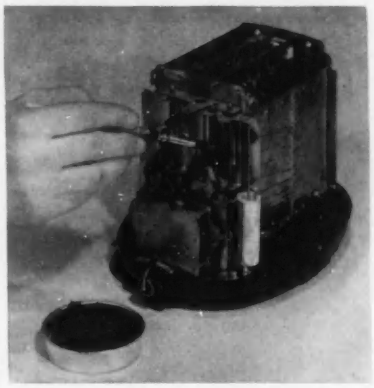
Because of its different molecular structure, Dow Corning 555 does not exhibit the unusually high order of water repellency generally associated with the standard dimethyl silicone fluids. However, an alcohol solution of the new Dow Corning 555 imparts water repellency to a much higher degree than any emulsion of the dimethyl silicone fluids, simply because it is not hindered by emulsifiers.

*Test areas where a skin cream made with Dow Corning 555 was applied are clearly visible when the entire hand is dipped in ink (left). The practical effectiveness of the cream becomes even more evident when the ink is rinsed off (right). Treated areas wash clean immediately, but vigorous scrubbing with strong soap is necessary to remove the rest of the stain.*

The temperature stability and oxidation resistance characteristics of Dow Corning 555 are excellent. Its useful temperature range, for instance, is from —70 to 300 F. *No. 68*

## Westinghouse is Always Sure With Silicone Lubricants

For the past six years Westinghouse Electric Corporation has employed Dow Corning silicone fluids and greases to assure lifetime lubrication for their automatic toasters. Besides being used on the latch lever pivot, Dow Corning 41 Grease is also brushed on the guide bars and latch bar, as shown in photograph. A Dow Corning fluid lubricant, 710R, is applied to the pivots and bearings of the toaster timer.



Despite operating temperatures ranging up to 400 F, these silicone lubricants stay in place without oxidizing or hardening. Six years of trouble-free service have convinced Westinghouse that they are ideal lubricants for the job. *No. 69*

### MINIATURE SNAP-SWITCH *(continued)*

Originally designed for aircraft, fire control and guided missile service, the new miniature switch is being applied to domestic and commercial washing machines, machine tools and other equipment exposed to liquids or moisture.

That's the kind of performance that has established Silastic as an ideal diaphragm material where pressures must be maintained despite temperatures from —100 to 500 F, weathering and oxidation, or in contact with a variety of oils and chemicals. Silastic is also unique among resilient dielectric materials because it combines high thermal conductivity with excellent resistance to moisture, corona and to fatigue. *No. 70*


**Silicone News** *is edited for product design and development engineers by* **DOW CORNING CORPORATION, MIDLAND, MICHIGAN**

*Branch Offices:* ATLANTA CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D. C. (Silver Spring, Md.)

Canada: Dow Corning Silicones Ltd., Toronto; England: Midland Silicones Ltd., London; France: St. Gobain, Paris

*Largest Producer of:* SILICONE Abhesives • Adhesives • Bonding Resins • Compounds Defoamers • Electrical Insulating Resins • Expansible Resins • Fluids • Greases Molding Compounds • Paint Resins • Release Agents • Water Repellents • Silastic

## want high speed plus endurance? How's this...

# 1000 HOURS at 3600 R.P.M. UNDER FULL LOAD!

If you were to drive 90,000 miles up an incline at 90 m.p.h., you would approximate the performance of the Model 24A, 331 cubic inch displacement Chrysler Industrial Engine pictured below.

To prove the power of Chrysler Industrial V8 Engines . . . their ability to run for long periods of time at high speed . . . on March 17, 1954 Chrysler engineers placed a production model Ind. 24A Engine on an endurance dynamometer at Chrysler Central Engineering Laboratories. Objective: 1000 hours operation at 3600 R.P.M. under full load.

*During every one of the 1000 hours, the Chrysler Ind. 24A Engine delivered an average of 174 horsepower* and when shut down, the engine was still in perfect operating condition.

During the run no service was necessary beyond minor maintenance care, such as oil changes and very infrequent spark plug changes and point adjustment. Yet, following disassembly of the engine, the only wear noted was negligible—no more than you might expect from an engine that has been operated for 1000 hours within a long period of time.

While there is every reason to believe that this is a record-breaking endurance run (and don't forget it was made at 3600 R.P.M. under full load), we are confident that every Chrysler Industrial V8 Engine will *at least equal* this astounding record.

This proves too, beyond a doubt, that the Chrysler Industrial V8 hemispherical combustion chamber design with its short-stroke, low-friction construction, makes an ideal power plant for any equipment that requires continuous high speed operation. Furthermore, in installing a Chrysler V8 Engine in preference to a diesel engine of similar horsepower, you can reduce your size estimate by one-half, your weight by two-thirds, and your cost factor by three-quarters!

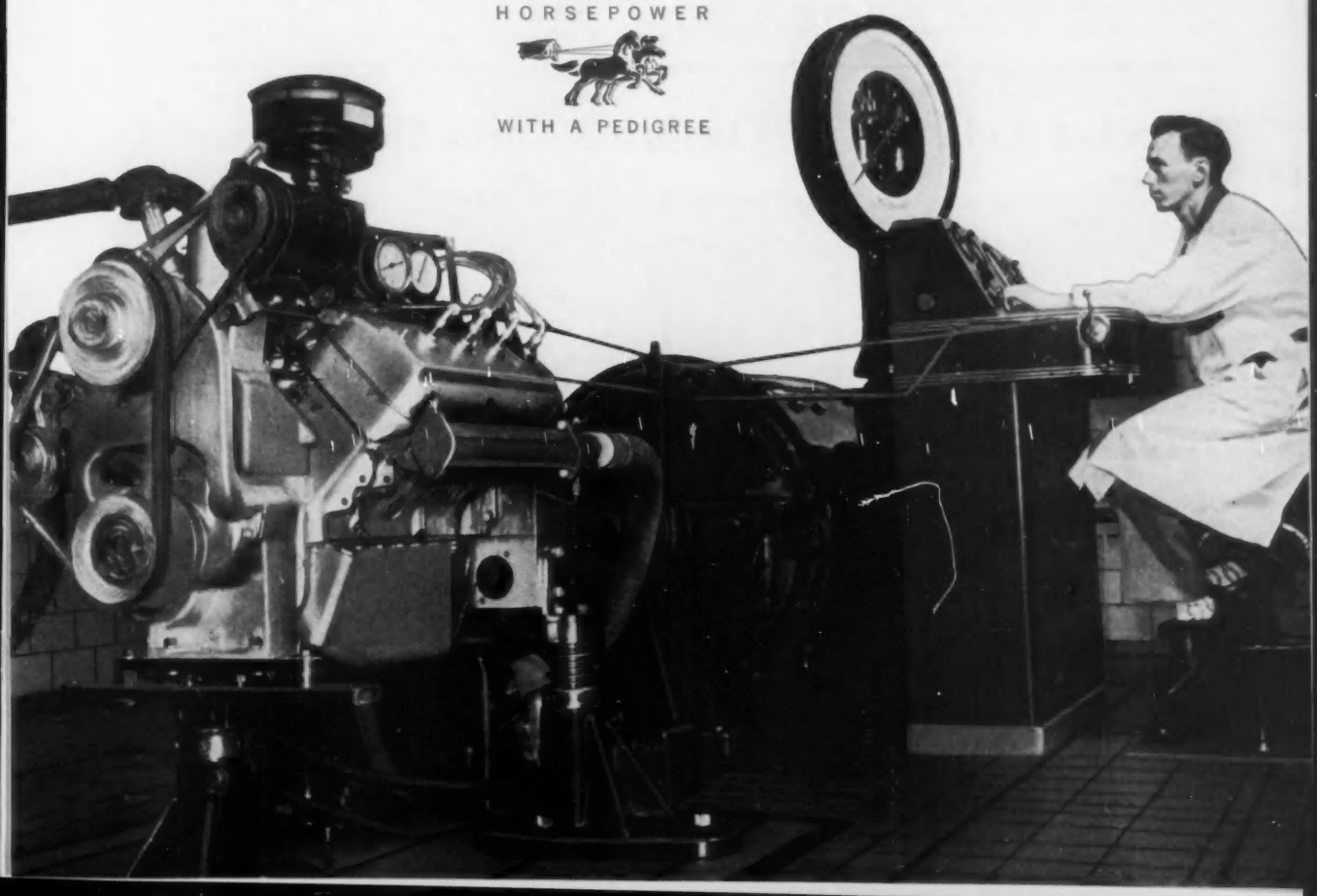
For detailed information on the Model 24A or any Chrysler Industrial Engine, see a Chrysler Industrial Engine Dealer, or write: ***Dept. 58, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***

## CHRYSLER *Industrial Engines*

INDUSTRIAL ENGINE DIVISION • CHRYSLER CORPORATION

HORSEPOWER

WITH A PEDIGREE



# Torque Limiter Built Into Flexible Coupling

Adjustable torque limiting coupling units that provide overload protection for a wide variety of machinery drives with direct-connected shafts are now available. These units are adaptable to motor drives with torque loads up to 260 ft-lb, which include a direct-coupled motor or motor-and-speed-reducer combination. In drives of this type the torque limiter-coupling unit connects the motor shaft or the output shaft of the speed reducer with the primary drive shaft.

The new device has a flat, molded friction disk with three integral lugs clamped between two steel driving plates by the action of a Bellville spring, tensioned by an adjusting nut. The driving plates are splined to a steel hub. The hub supporting the torque limiter components is keyed to the shaft.

Flexible coupling action is achieved by meshing the lugs on the outside diameter of the disk with a slotted steel cup which is keyed to the shaft. This slotted lug and cup combination permits the units to function properly regardless of minor misalignment errors between driving and driven shafts.

When machine drive overload conditions cause the torque limit setting to be exceeded, the friction disk breaks away from the driving plates and will then slip at from one-third to one-half the torque setting. The drive is rendered inoperative, protecting motor, machine and drive components from overload until the motor is shut off and the overload condition corrected.

In contrast with arrangements involving shear pins or other types of overload protection mechanisms, the torque limiter does not require resetting or maintenance before the drive is put back into operation. The torque setting of the unit can be adjusted by the nut to provide desired overload setting up to the maximum rated capacity.

These new type torque limiter-coupling units are made in a $5\frac{1}{2}$ in. size. Maximum torque capacities are 130 ft-lb for the Model 555-1 and 260 ft-lb for the Model 555-2. The units have a 6 in. OD and are approximately $5\frac{1}{2}$ in. long, overall. Standard bore sizes are 1, $1\frac{1}{8}$, $1\frac{1}{4}$, $1\frac{3}{8}$ and $1\frac{1}{2}$ in. for both models. Minimum plain bore size is $\frac{3}{4}$ in. for reworking to fit other than the standard bore sizes.

*Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.*

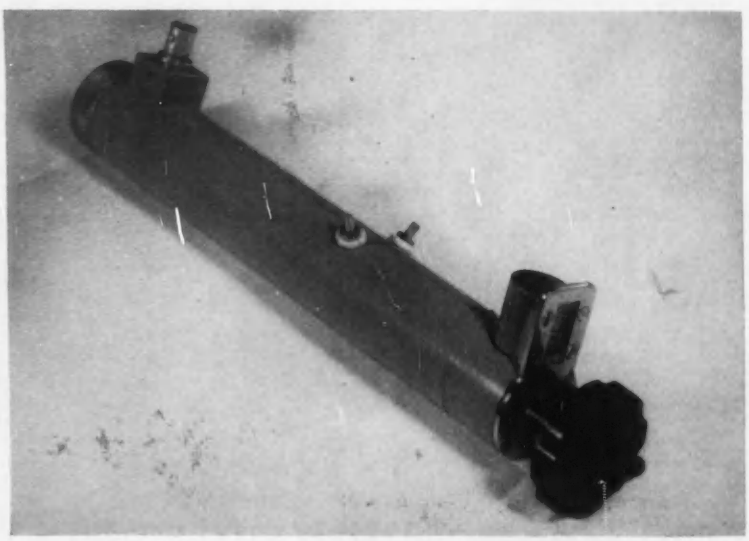
# Rocket Tube Cavity Oscillator With Single Control

A small-size, co-axial line cavity oscillator, employing a UHF planar triode tube, provides a stable signal source of either continuous wave or pulse type radio frequency energy. The unit features a single knob control and utilizes fixed feedback.

The new oscillator is 8 in. long $1\frac{5}{16}$ in. dia and weighs 1 lb, 3 oz (including tuning mechanism). It can also be supplied as a cavity alone—4 x $1\frac{5}{16}$ dia, weighing only $\frac{3}{4}$ lb.

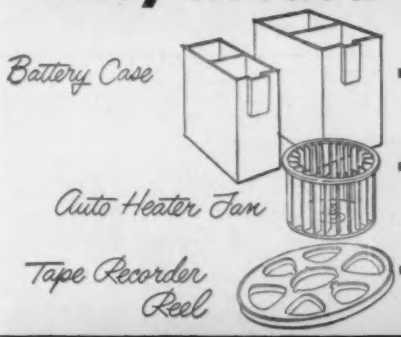
It is available at frequencies from 1000 to 4000 mc with a tuning range of 400 mc/s. Pulse operation is 2000 peak volts with a peak pulse power of 200 watts. Continuous wave operation is 175 v with an average output power of 100 mw. Tuning accuracy is $\pm 0.1$ percent with regulated power supply.

*Amerac, Inc., 116 Topsfield Rd., Wendham, Mass.*



CONTINUED ON PAGE 228

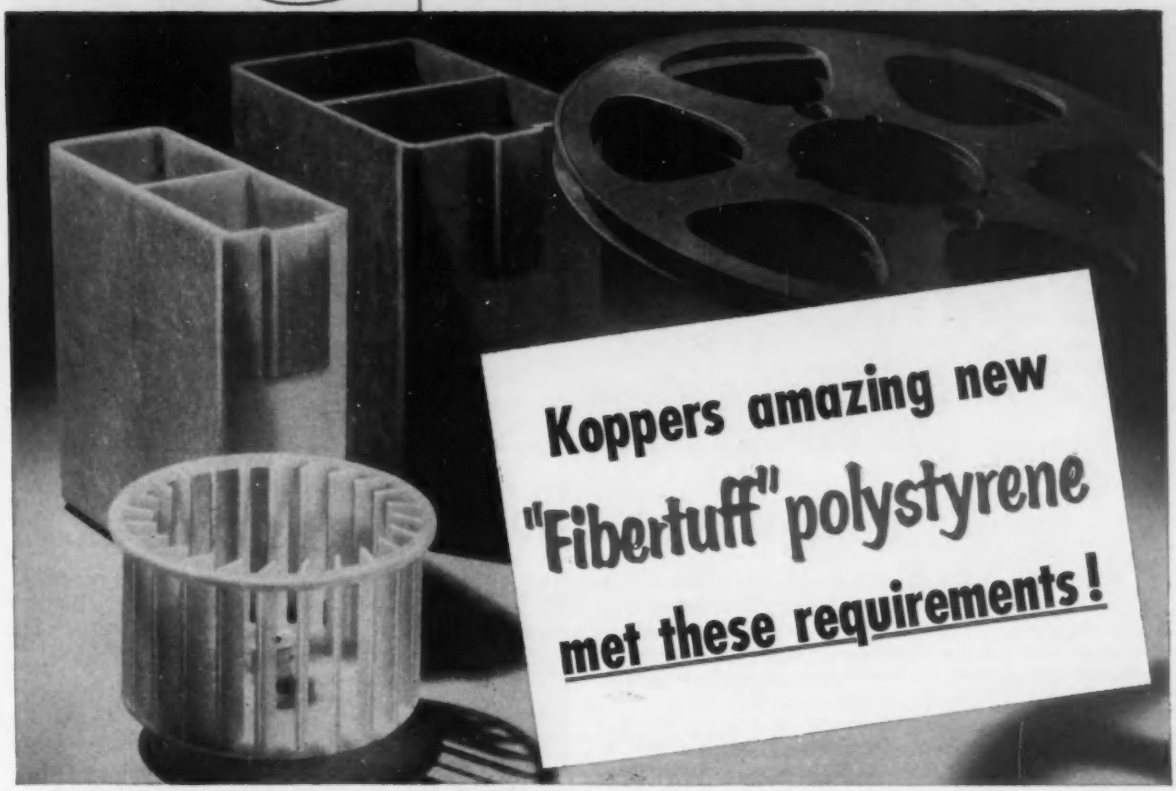
# They needed a plastic that was




— heat and shock resistant

— strong and rigid

— dimensionally stable




**KOPPERS POLYSTYRENES**

| | |
|---|---|
| Type 3 | General Purpose Polystyrene |
| Type 7 | Improved Heat Distortion Temperature |
| Type 8 | Highest Heat Distortion Temperature |
| MC-185 | "High Impact," Lowest Water Absorption Rate |
| MC-305 | "High Impact," Easy Flow |
| MC-309 | "High Impact," Highest Heat Distortion Temperature |
| MC-405 | "Medium Impact," Easy Flow |
| MC-409 | "Medium Impact," Highest Heat Distortion Temperature |

● New "Fibertuff" Polystyrene is extra strong and rigid because it is reinforced with thousands of glass fibers. Make your products with "Fibertuff" Polystyrene and they'll keep their mold dimensions, and resist shock despite heat and cold. In addition, it is available in colors.

"Fibertuff" Polystyrene is a glass reinforced polystyrene designed for use in conventional injection molding equipment. It has been thoroughly tested in the field. For more information about "Fibertuff" Polystyrene, write to us today.

*Koppers Plastics Make Many Products Better and Many Better Products Possible.*

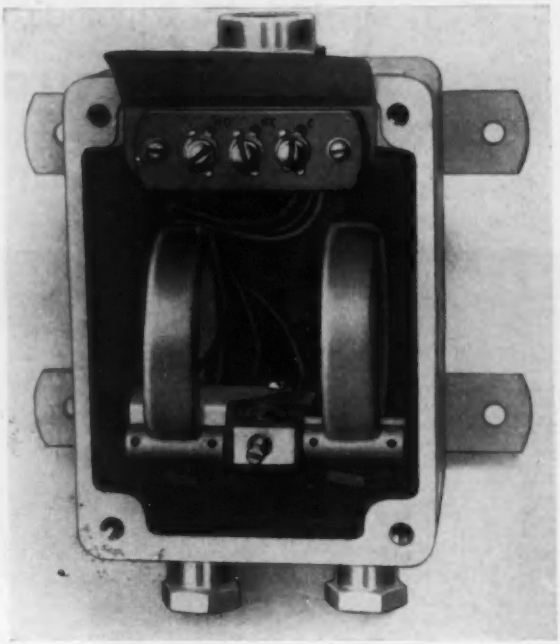
KOPPERS®

**Koppers Plastics**

**KOPPERS COMPANY, INC., Chemical Division, Dept. PE-84, PITTSBURGH 19, PENNSYLVANIA**

SALES OFFICES: NEW YORK · BOSTON · PHILADELPHIA · ATLANTA · CHICAGO · DETROIT · LOS ANGELES

# Pressure Sensing Switch Uses Bourdon Tubes



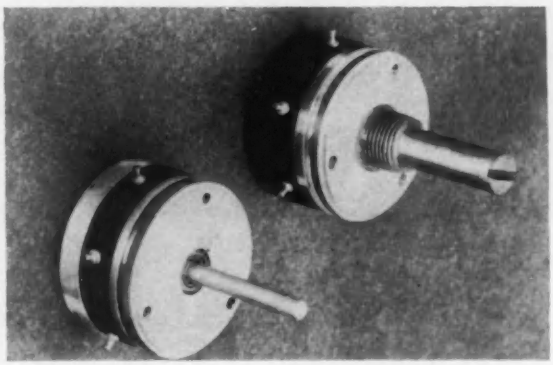
By sensing a pressure difference between two variable pressures or a variable and a reference pressure, a new switch can be used to operate relays, solenoids, motor controls and similar devices. Available in 4 classes of proof pressures from 500 to 12,000 psi, this pressure switch permits opening or closing of a circuit on increasing or decreasing pressure difference at any point within the adjustable range of the model selected.

Two parallel bourdon tube sensing elements provide extreme repetitive accuracy for the control of the most delicate processes or the protection of sensitive instruments and costly equipment. Model 532 operates in any position, simplifying installation and facilitating portable installations. No balancing or levelling is necessary.

The entire mechanism is housed in a splash-proof enclosure as protection against dust or damage in exposed locations. A tamper-proof external adjustment is provided for field setting. The unit incorporates an UL-approved snap action, single pole, double throw switching element rated for a-c and d-c circuits.

*Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.*

# Full Voltage With 3 Deg Shaft Rotation



The entire voltage output of these step-function potentiometers is obtained over a shaft rotation of only 3 deg. The voltage sensitivity is asserted to be more than one hundred times that of the conventional one-turn potentiometer. It is the first sensitive potentiometer for transducer applications involving minute angular motions.

Unlike the relay and switch types of controls formerly used for such work the input to the clutch or motor coils of this unit is directly proportional to the relative displacement of input and output shafts. Thus response is immediate and, with oscillations minimized, dead space is zero.

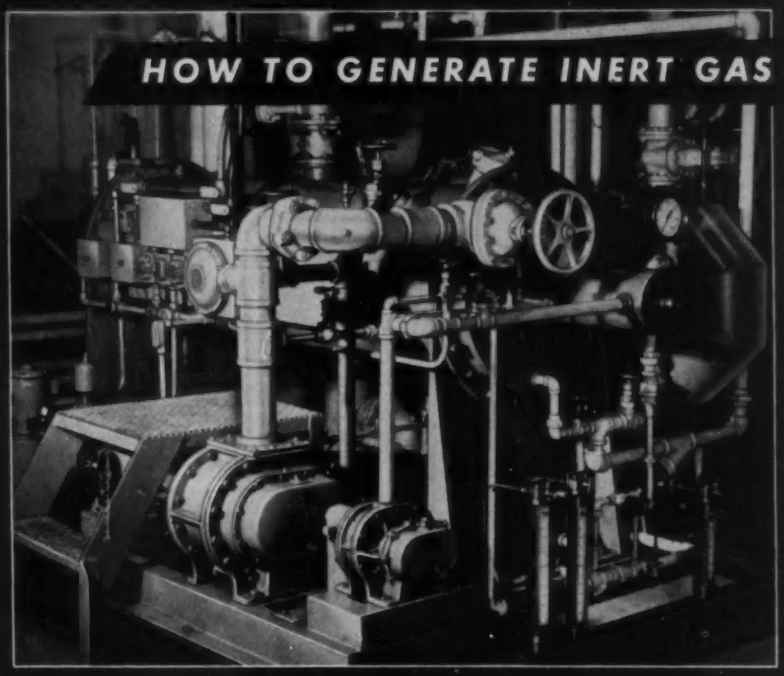
A torque of as little as 0.1 in.-oz will make the potentiometer shaft rotate, and the resulting electrical signal will cause the motor shaft to rotate. This drives the potentiometer case directly (or through a suitable gear reduction) in such a direction as to reduce the potentiometer output signal and develop the stall torque of the motor, which typically ranges from 2 to 4 in.-oz.

*Computer Instruments Co., 1964 Utica Ave., Brooklyn 34, N. Y.*

FLOAT-TYPE WATER EJECTOR automatically discharges accumulated water from any pneumatic system into the bottom of an air line filter bowl or into a drain line at any place in the layout. Dry air is assured at all times regardless of humidity or other contributing factors. Water is automatically discharged upon the accumulation of 3 to 4 oz and complete discharge is accomplished within 5 sec, depending on line air pressure. Each unit has a capacity of up to 20 gph. A sump is provided for periodic cleanout of dirt. The unit is light, weighing only 1 lb, 7 oz. Overall dimensions are 4¼ in. OD, 5 in. high. All parts are noncorrosive and the needle type valve has a renewable seat which is easily replaceable. No special tools are required for installation or maintenance of this float-type water ejector. American Injector Co., 1000 E. McNichols Rd., Detroit 3, Mich.

CONTINUED ON PAGE 230

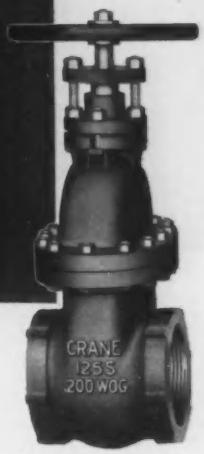
## HOW TO GENERATE INERT GAS IN VOLUME



## another successful product design with piping equipment by CRANE

Inert gas can be generated at the rate of 18,000 c.f.h. in this variable capacity unit by *Roots-Connersville Blower* of Connersville, Indiana. This division of Dresser Industries Inc. is also recognized for rotary positive blowers for pressure and suction, gas exhausters and boosters, cycloidal pumps for handling viscous liquids, gas and liquid meters, centrifugal blowers and exhausters, and also vacuum pumps.

Designing dependability into a wide range of equipment like this is a big job made easier when you specify Crane quality for the valves and fittings. The broad Crane line eliminates the need for selecting dubious alternates. And the complete Crane Catalog gives you full data for every piping item . . . sizes and dimensions, temperature and pressure ratings, plus details on materials and construction. Big reasons all, why Crane is the piping choice of so many product designers.




Crane 125-Pound Iron Body Wedge Gate Valve . . . recommended for all services where greater strength and long valve life are of prime importance. Body and bonnet are oval-shaped with extra metal where it's needed most. Flanged patterns have tie-ribs between body and bonnet. Long guides assure proper seating of the solid web-type disc. An exceptionally deep stuffing box filled with high-grade packing provides a tight stem seal. Selection includes all-iron or brass-trimmed valves in non-rising stem or OS&Y patterns. Sizes up to 48-inch. You can also specify OS&Y valves with brass seats and steel stem.

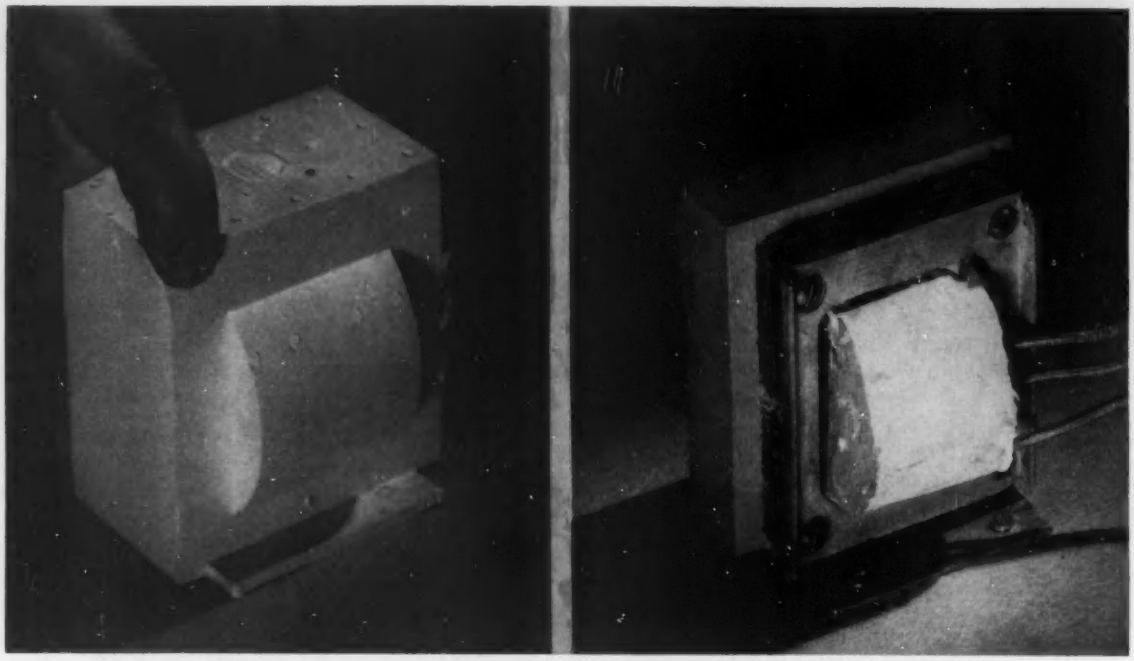
**YOU'LL FIND IT HERE ...IN YOUR CRANE CATALOG**

*THE BETTER QUALITY...BIGGER VALUE LINE...IN BRASS, STEEL, IRON*

# CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
*Branches and Wholesalers Serving All Industrial Areas*

**VALVES · FITTINGS · PIPE · PLUMBING · HEATING**



# Encapsulating Material for Extreme Temperatures

A resilient dielectric coating or encapsulating material for extreme temperature electric and electronic components has been developed. It is a new silicone rubber that cures in 2 to 4 hr at 200 C. It forms a rubberlike jacket which is asserted to be uniform, heat-stable, moistureproof and highly resistant to oxidation, ozone and weathering.

Tests indicate that transformers properly coated with this new material will easily pass both the moisture resistance and low-temperature flexibility requirements of Mil-T-27, Grade 1. Fully cured coatings also have about twice the thermal conductivity of conventional resinous or rubber dielectrics, assuring cooler operation at high temperatures.

Supplied as a solvent-free, low-consistency paste, Silastic S-2007 may be applied by dipping, vacuum impregnating, or may be molded in encapsulating molds. Coated parts may be placed directly into a hot air oven for vulcanization. Neither pressure nor a graduated cure is necessary.

Normally white, it may be tinted any shade by the user with heat-stable pigments. Fully cured coatings have a hardness in the range of 40 durometer, Shore A scale. Material cost is comparable to that of standard raw stocks of similar types produced by this company.

*Dow Corning Corp., Midland, Mich.*

# Potentiometer With 360 Deg Electrical Rotation

A new $\frac{7}{8}$-in. potentiometer, available with up to 360 deg electrical rotation as well as mechanical rotation, in resistance ranges up to 50,000 ohms ($\pm 1$ percent) features a unique assembly method similar to that used in precision watchmaking. The resistance element and its mounting, like a watch movement, is pre-assembled and then placed into the housing. The complete unit weighs only $\frac{1}{2}$ oz.

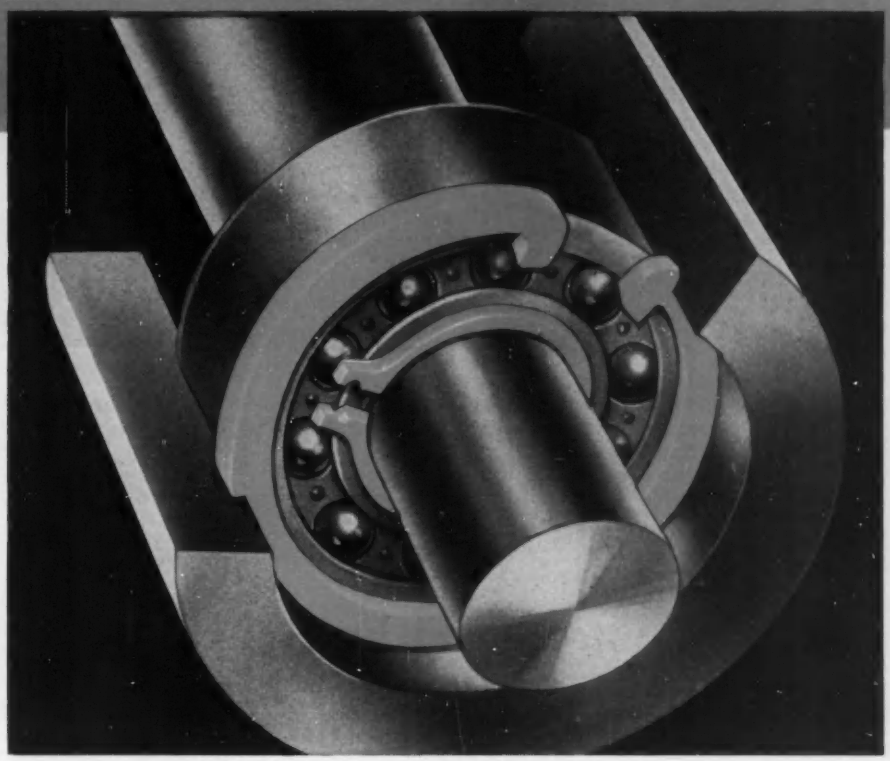
The new unit has an anodized aluminum case, with phosphor bronze bushing. A centerless ground stainless steel shaft $\frac{1}{8}$-in. dia is supported by front and rear sleeve bearings (or ball bearings if specified). Paliney contact material is used between the rotor and resistance element. The rotor take-off brushes are made of gold alloy and rotate on a coin-silver ring. The use of these precious metals on the moving parts gives the potentiometer a life expectancy in excess of over one million cycles of noise-free operation.

Windings are available, with linearity guaranteed to within $\pm 1$ percent of total resistance. The units are rated at 1 w at 25 C and the resistance alloy has a temperature coefficient of 0.00002 parts per degree C for values of 500 ohms or more. The ambient temperature rating is from —67 F to 250 F. Terminal board material withstands 250 F. Terminals are available in silver or gold plating.

*Electronics, Inc.,*
*93 Massachusetts Ave., Boston, Mass.*

CONTINUED ON PAGE 232

# •Save Time •Save Materials •Save Money!



Examine the designs of **all** your products and machines. No doubt you can use retaining rings on axles and in housings – not **only to save assembly time, but to save weight, parts and space.**

The use of these inexpensive yet efficient artificial shoulders is already widespread, and is increasing daily.

There are literally thousands of places in which redesigning for retaining rings can increase your profits and improve your products – uses ranging from heavy duty engines and drill presses to toys, gadgets and small parts of innumerable articles.

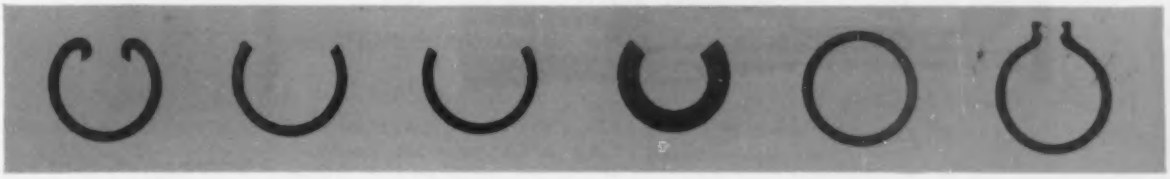
It's wasteful to cut down shafts to make shoulders. Redesign to groove smaller shafts and housings and use these high grade steel rings.

Let our engineers consult with you. Send for folders.

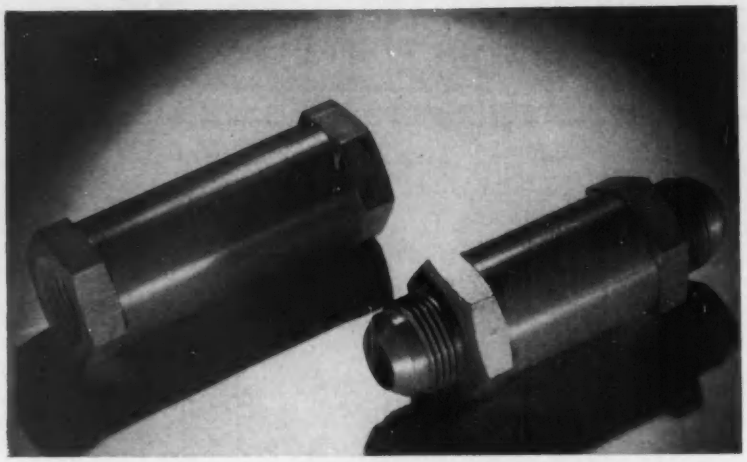
Don't pass up this opportunity to increase profits.

## THE NATIONAL LOCK WASHER CO.

**NEWARK 5, NEW JERSEY • MILWAUKEE 2, WISCONSIN**



# Hydraulic Check Valves For Up to 3000 Psi



Two new series of high-pressure free-flow check valves can be used on all hydraulic systems operating at pressures up to 3000 psi. They may be mounted in any position, and it is stated that they have been designed for fast opening and delivery of full line capacity with minimum pressure drop.

Valves of the "CIS" series are of the cone type design, with JIC flared tube connections which mate with sleeve and nuts. Presently, there are five models in this series, all of which are available for immediate delivery. Overall lengths (including connections) of these CIS valves are: $2\frac{7}{8}$, $3\frac{17}{32}$, $3\frac{15}{16}$, $4\frac{15}{32}$, and $5\frac{1}{8}$ in. Respective weights are: 0.313, 0.487, 0.606, 1.062 and 1.612 lb.

Valves of the CIT series are of the in-line cone design with internal thread connections. Presently, there are five models in this series also, all of which are available for immediate delivery. Overall lengths of these CIT valves are: 3, $3\frac{3}{8}$, $3\frac{29}{32}$, $4\frac{1}{2}$ and $5\frac{1}{8}$ in. Respective weights are: 0.206, 0.550, 0.705, 1.125, and 1.500 lb.

The rated flow of both valve series (from 3 to 28 gpm) is based on hydraulic oil having a viscosity of 150 SSU at 100 F. Valves furnished with either 5 or 65 psi cracking pressure.

*Parker Appliance Co.,*
17325 *Euclid Ave., Cleveland* 12, *Ohio*

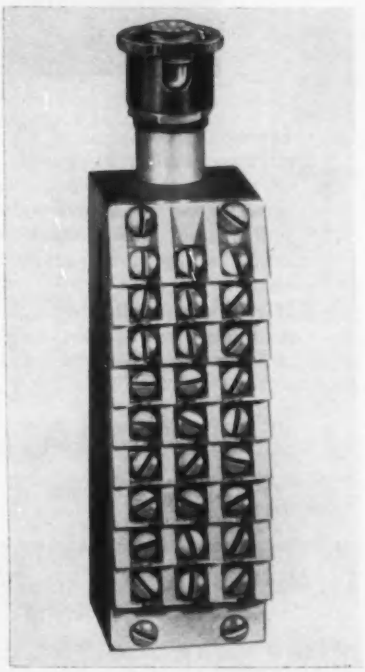
# Positive Control of Eight Primary Circuits

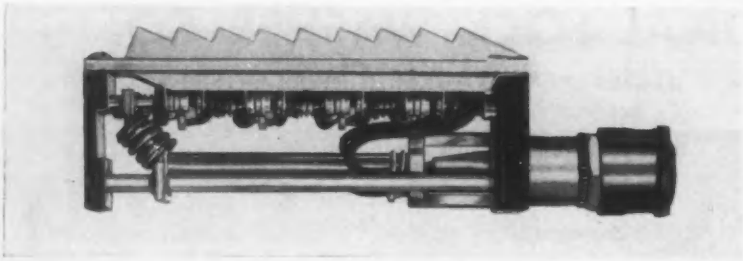
With this new eight-pole, double-throw switch, pushing a button or throwing a lever switches on or disconnects eight primary circuits for complete control of multiple machine operations. It may be used for such purposes as stopping carriers, releasing machine loads, stopping or starting machines, shutting off boiler feeds, dumping fuel or starting extinguishers.

Constant contact pressure (4 oz per point) is maintained throughout the stroke until positive snap-action occurs in either direction. There is no dead center. Contacts handle 5 amp 28 v, dc, inductive; 10 amps, 115 v, dc, non-inductive; 60 to 400 cycles. The unit is designed to exceed military specifications ANS-63, to resist shock and vibration and to operate at temperatures varying from —65 to 160 F.

Multiple wiring to each terminal may be accomplished with ease, it is asserted. Unit mounts on $1\frac{1}{2}$ x $1\frac{1}{4}$ in. panel area, requiring no more space than two toggle switches. Weight of this unit is approximately 8 oz.

*Guardian Electric Mfg. Co.,*
1621-*MA W. Walnut St., Chicago* 12, *Ill.*





CONTINUED ON PAGE 234

STAINLESS STYLE

This mobile canteen, a light truck conversion by Davis & Sewell of Baltimore, illustrates some vitally important properties of Crucible Rezistal® stainless steels.

To begin with, Crucible stainless is easy to keep clean, no matter how many "hot-dogs-with-the-works" are put out every day. A quick once-over with soap and water and the stainless keeps its new look – the surface can't chip or wear away.

Probably more important – Crucible stainless is truly a *practical shop metal*. You can bend it, draw it, spin it, weld it, machine it – do anything with stainless, in fact, that you can do with ordinary steel. At the same time, your designs can take full advantage of stainless steel's superior physical properties and corrosion-resistance to save weight without sacrificing strength.

So remember: corrosion-resistance isn't the *only* outstanding property of Crucible stainless steels. These famous alloys also feature excellent fatigue, creep and structural strength . . . high abrasion-resistance . . . resistance to high or low temperatures . . . practical workability. Let us show you how stainless can help solve some of your knotty problems. For prompt action – just call Crucible.

**CRUCIBLE** first name in special purpose steels

54 years of Fine steelmaking **STAINLESS STEELS**

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • REZISTAL STAINLESS • MAX-EL • ALLOY • SPECIAL PURPOSE STEELS

Canadian Distributor — Railway & Power Engineering Corp., Ltd.

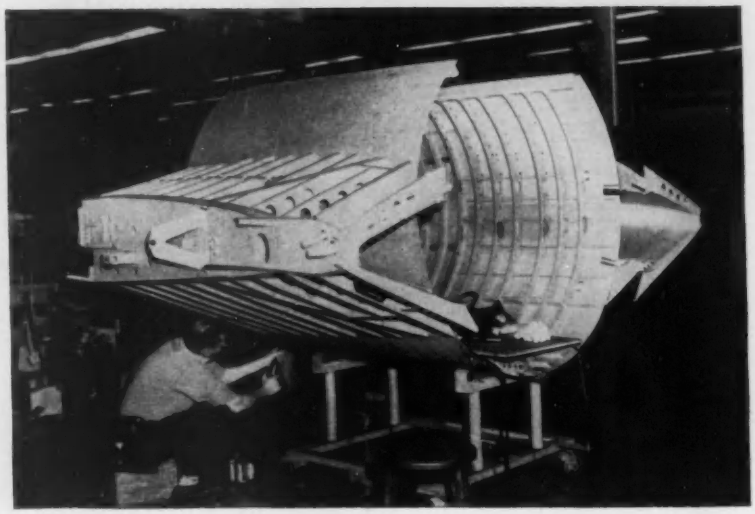
# Lightweight Fasteners for Temperatures to 1200 F

Four new lines of nuts are reported to be permitting weight savings throughout the whole range of aircraft locknut applications.

The four new lines cover small and large sizes; hex, anchor, and gang channel nuts for all ranges of temperatures from —70 to 1200 F. The new nuts will be used in assembling basic aircraft structures, attaching components such as carburetors or pumps and parts such as access panels, and in assembling and attaching accessories such as armament, electronic gear and bombsights.

Weight reductions are of the order of 0.5 to 2.5 lb per 100 nuts.

The new lines are: (1) "Blue J" type locknuts made of high strength aluminum alloy, which meet AN tensile strength requirements for steel nuts of the same thread size; (2) "Type Y" nuts, which because of their 12-point (double-hex) design can be smaller and lighter than regular hex nuts with no sacrifice in strength; (3) "Type LH" nuts, a new all-metal locknut design for use up to 550 F meeting the same AN specifications as equivalent beam-type nuts made by the same company; (4) "ZA1W" nuts for service up to 1200 F. In this last series, a new anchor nut design is available meeting the same AN high temperature specifications as existing anchor nuts, with cost and weight reduced. In addition, a new, lighter, floating anchor nut designated "A401", with reduced envelope dimensions, has also been made available in the Blue J and LH lines. Nylon is used as the insert on all fixed nuts.



All types of the new nuts can be used with steel bolts and all of them have been approved for use on Air Force, Army and Navy aircraft.

As a conservative example of potential weight savings, data supplied by a major aircraft manufacturer made it possible to estimate that if these newly introduced nuts were to be used on all the structures assembled in that plant, it would result in a direct saving of 115 lb in a medium bomber. This figure does not include replacement of the thousands of nuts on components and equipment assembled elsewhere for use in this aircraft.

A major airline, counting the other types of nuts it bought last year from the same maker for maintenance and repair operations on its fleet, finds it would have saved over 4000 lb if the new lightweight fasteners had been available. Since this airline figures that a pound of weight saved on a plane results in $20 additional revenue per year, this could mean an addition of $80,000 to its annual income.

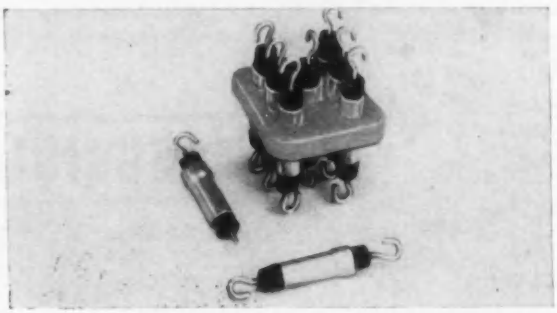
Many of these new lines and configurations of locknuts are in stock and available in all sizes and types commonly used in aircraft. They will be made in other sizes as the aircraft industry requires them.

*Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N. J.*

# Hermetically Sealed Rubber Terminals

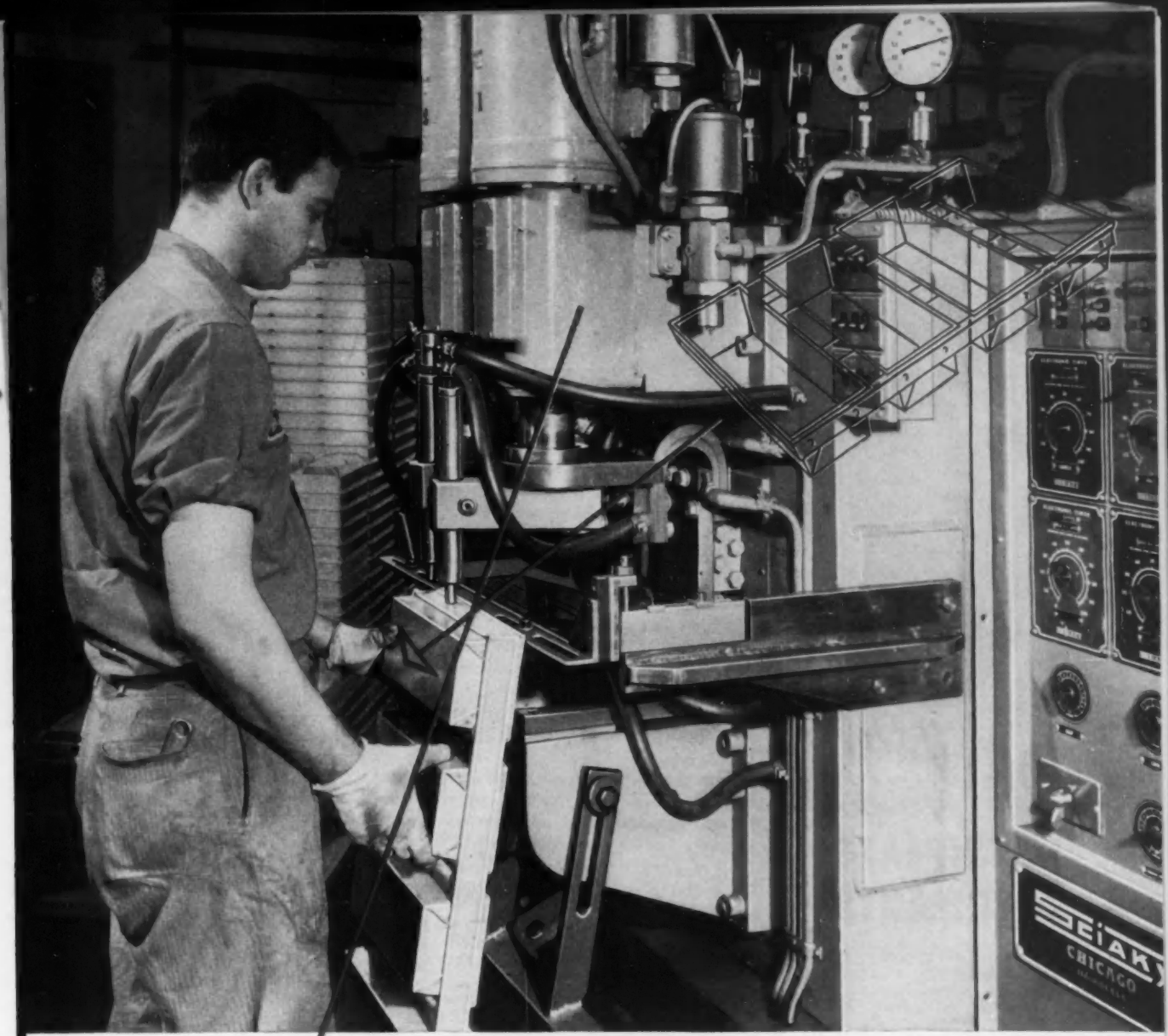
These new, hermetically sealed feed-through terminals are formed of rubber-insulated, copper-clad steel wire. Excellent sealing properties are achieved by crimping a tinned copper sleeve over the rubber insulation, which is chemically bonded to the wire.

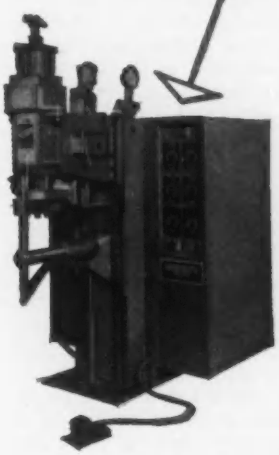
These terminals are reported to provide high leakage resistance, high dielectric strength and to prevent metallic migration under dc potentials. Oil leakage is prevented even under internal pressures of 30 psi. The rubber insulation also absorbs shock and vibration.



*Pilot International Corp., 27-01 Bridge Plaza, Long Island City 1, N. Y.*

CONTINUED ON PAGE 236



# Redesign for Resistance Welding Pushes Trend to Aluminum Bread Pans

The Lockwood Manufacturing Company, Cincinnati, Ohio, manufacture their aluminum bread pans with Sciaky Patented Three-Phase spot welded construction. Rapidly replacing conventional riveted aluminum pans, the spot welded aluminum pans are more durable, more sanitary, safer to handle, and bake a superior product. Further, the production ability and consistency of Sciaky Three-Phase welders reduces fabricating costs. As a result, more and more bakers are using aluminum pans and reaping the benefits of their light weight and long life. For complete details, write for "Resistance Welding at Work," Volume 3, — No. 10

The Three-Phase spot welding of aluminum bread pans at Lockwood is another fine example of Sciaky basic thinking — welders designed to do *more useful work* at *lowest operating cost* with *maximum reliability.*

*Largest Manufacturers of Electric Resistance Welding Machines in the World*

SCIAKY

**Sciaky Bros., Inc., 4913 West 67th Street, Chicago 38, Illinois**

FORWARD!

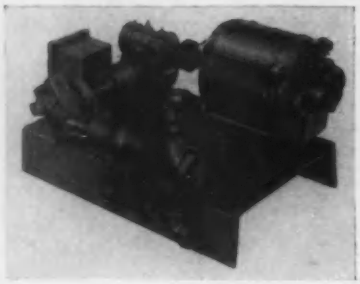
by

**LUBRIPLATE LUBRICANTS**

The introduction of LUBRIPLATE Lubricants established a new high standard for industrial lubrication. Now, a recently patented improvement in the production of LUBRIPLATE results in even greater lubrication efficiency. Under today's operating costs, reduction of down time, less parts wear and replacements, as well as lower power consumption, far outweigh any differential in the initial cost of LUBRIPLATE Lubricants.

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Write for your free copy of the new and enlarged LUBRIPLATE DATA BOOK—a most valuable treatise on modern lubrication!

**LUBRIPLATE DIVISION**
Fiske Brothers Refining Co.
Newark 5, N. J. • Toledo 5, Ohio



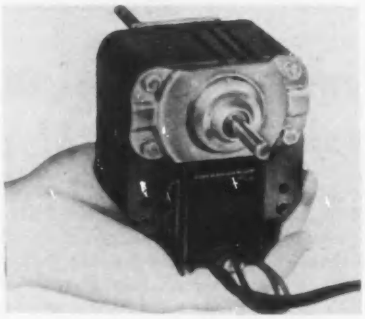
## Pump for Proportional Feed Systems

A new, motor-driven, controlled volume pump for use in proportional feed systems has a mechanical, single revolution clutch arrangement which permits one stroke of the pump in response to an electrical signal to effect feed of an additive in proportion to main line flow rate. This signal may be transmitted by a timer, electrical contacts on a positive displacement meter or by still other means.

Capacities are from 1 pint to 135 gph, against discharge pressures up to 50,000 psi.

This type of proportional feed system can be used, for example, to meter octane appreciators and inhibitors in the petroleum industry, color and perfume in the soap and cosmetics industry, blending and formulating in the chemical processing industry.

*Milton Roy Co., Station Q, 1300 E. Mermaid Lane, Philadelphia 18, Pa.*



## Shaded Pole Motor With High Starting Torque

Shaded pole motors operating on a new principle resulting in high starting torques and increased efficiency are now in production. Because of the short length and offset shaft, the motors are adaptable to application where space is at a premium. The motor is basically a constant 3,000 rpm, 2-pole motor. Shaft, mounting studs and fan can be modified to meet customer's specifications.

Available from 1/40 to $\frac{1}{8}$ hp, these motors are recommended for use on washing and ironing machines, oil burners, centrifugal pumps, fans and blowers, recording apparatus, food mixers, home workshop grinders, condensing units.

*Northwestern Electric Co., 1750 N. Springfield Ave., Chicago, Ill.*

## Single Turn, Continuous Rotation Potentiometer

The new "J series" potentiometer is a high precision, single turn, continuous rotation unit for servo mounting. Resistance from 2 ohms to 100,000 ohms can be provided, with tolerance as close as ± 1 percent. Linearity tolerance of ±0.25 percent can be achieved in resistances below 10,000 ohms, and ±0.15 percent in resistances of 10,000 ohms and above.

Power rating is 4 w at 40 C ambient. Because the resistance wire of the coil is wound on a copper mandrel, and heat is dissipated over the entire length of this mandrel even when only a portion of the coil is used, derating of power is never necessary at ambients up to 40 C.

Up to 21 extra taps can be added to one of these devices, and each is spot-welded to a single-turn of resistance wire, without shorting out adjacent turns.

As many as six sections can be ganged on one shaft, and sections can be ganged with potentiometers of other series. The unit is 2 in. dia. Over-all length is $1\frac{19}{32}$ in. for a single section; each additional section of a ganged assembly adds $\frac{19}{64}$ in. to the overall length. External metal clamps permit rapid phasing of any section,

# Everything's Under Control with **DRIVES** and **TRANSMISSIONS**

by BREEZE MARK

**TEE DRIVE**
Precision geared for actuators connected in series

**90° ACTUATOR DRIVE**
For direct connection to actuator that pivots in trunion mounting

**TORQUE TUBE DRIVE**
For transmitting torque between torque tube and flexible shaft.

**90° DRIVE**
Precision gearing, double ball bearing suspension Sealed and lubricated

● To actuate tabs, flaps, shutters and other aircraft mechanisms with positive, precision control, the industry long has relied on Breeze drives and transmissions. From simple mechanical drives and direct reading indicator drives to electrical and hydraulic actuators, Breeze offers a complete line, affording a wide choice of components and assemblies to meet many individual design needs.

Shown here are examples of Breeze-engineered lightweight mechanical drives, having connections to mate with flexible shaft drives. The 90° and TEE drives may be mounted in any position with relation to an actuator mounting.

Inherent in all these designs are features dictated by specific aircraft needs and experience. You may find the assemblies you require in our wide variety, thus saving design and tooling costs. Or, our engineers will design and custom build to your special requirements.

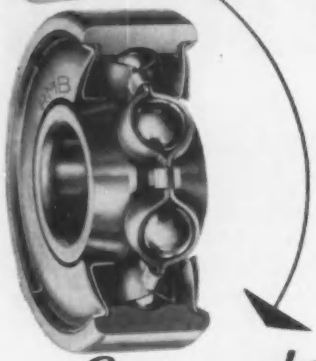
We invite consultation. Write for our complete informative catalog.

# BREEZE

**CORPORATIONS, INC.**
700 Liberty Ave., Union, N. J.

**OTHER BREEZE PRECISION PRODUCTS** Special Connectors Actuators • Ignition Shielding • Aero-Seal Worm Drive Hose Clamps

HERE'S WHAT *We* MEAN BY—



*Miniature*

**BEARINGS!**

**TYPE RF**

**FILMOSEAL**

**from 0.1969" O.D.**

**Smallest Sealed Retainer Type Radial Ball Bearing**

***An RMB First***

This is a miniature bearing! It looks like a big bearing, doesn't it? That's because it has all the features of a big bearing, such as—

- Deep groove races
- Balanced two-piece or snap-type ball retainer
- Non-rubbing capillary oil seal
- Removable and replaceable dust shield
- Precision tolerances

RMB Type RF Filmoseal bearings (illustrated) are available in sizes from 0.1969" O.D.

*Type RF now available in R2 size (ABEC-1, 3, 5) (⅛" bore—⅜" O.D.)*

***Bring your Miniature Bearing Problems to RMB***

A complete line of over 250 miniature and instrument bearings including radial and roller types available for prompt delivery. Experimental quantities from stock.

**Write for catalog 12**
**Or see our catalog in Sweet's Files.**

RMB LANDIS & GYR, INCORPORATED

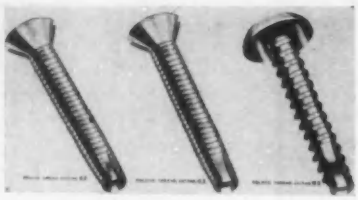
45 WEST 45TH ST. • NEW YORK 36, N. Y.



even after installation. Either precision miniature ball bearings or sleeve bearings are available.

Other construction features include aluminum alloy lids, centerless-ground stainless steel shaft, precious metal contacts and slip ring, and gold-plated terminals. All machining is to extremely close tolerances.

*Helipot Corp., Div. of Beckman Instruments, Inc., South Pasadena, Calif. & Mountainside, N. J.*



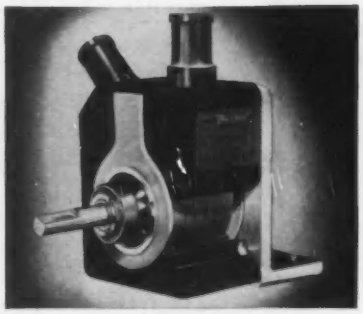
## Tapping Screws With Two Edges

Thread-cutting screws with balanced cutting edges are described as requiring less driving torque. Wider flutes provide increased chip room.

The new fastenings are made of alloy steel, heat treated. They are also available in aluminum, brass and stainless steel.

These screws are for use, according to type, in steel and cast iron, in die-castings, in plastics (can sometimes eliminate need for threaded inserts).

*Continental Screw Co., New Bedford, Mass.*



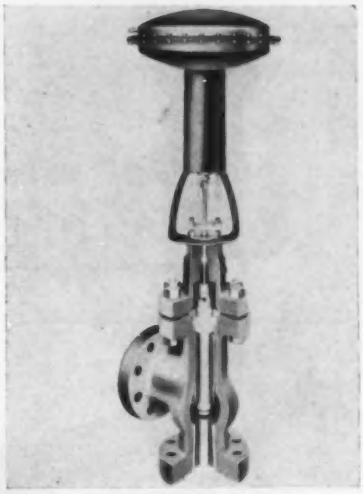
## Pump With Unplasticized Rigid PVC Block

The use of unplasticized rigid polyvinyl chloride for a pump block makes a new pump useful in barrelling most acids, alkalis, salts, oxidizing agents, oils, greases and alcohols. Since this rigid PVC is processed without plasticizers it is asserted that the full utilization of the chemical inertness and inherent strength, light weight and toughness of the straight polyvinyl chloride resins is provided.

These new pumps are self-priming and do not contain stuffing boxes or shaft seals of any sort. Their design restricts the fluid to contact with the inner surface of the polyvinyl chloride block and the outer surface of the liner, which is also available in this material. The activating element is an eccentric shaft and rotor assembly which rotates inside the liner. Molded flanges straddle the body block and are pressed to its sides by end plates, completely sealing off the fluid passage.

Capacities from ¼ to 20 gpm are attained with pressures up to 60 psi and vacuum to 26 in. Hg.

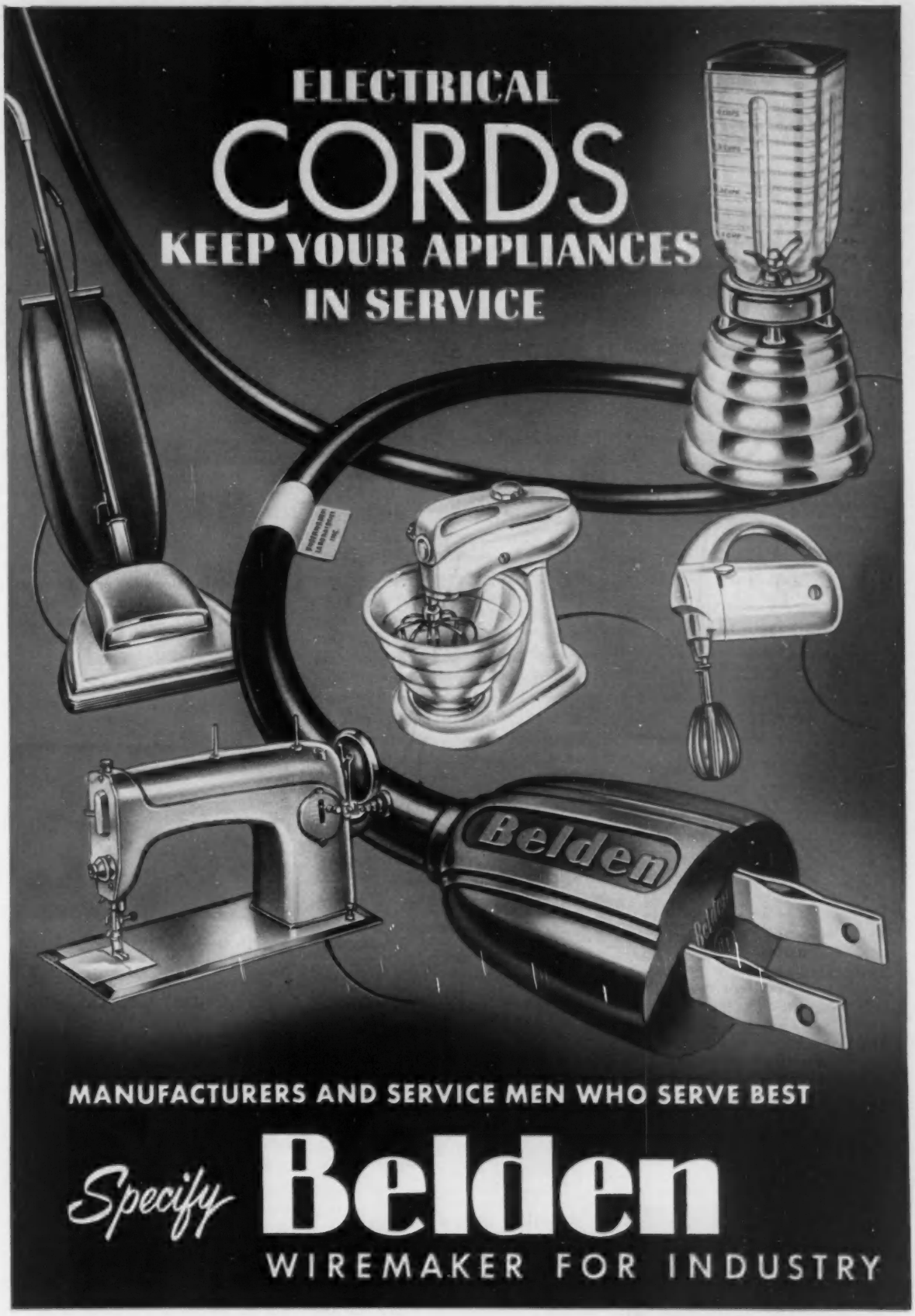
*Vanton Pump & Equipment Corp., Empire State Bldg., New York 1, N. Y.*



## New Valve Held Shut By Line Pressure

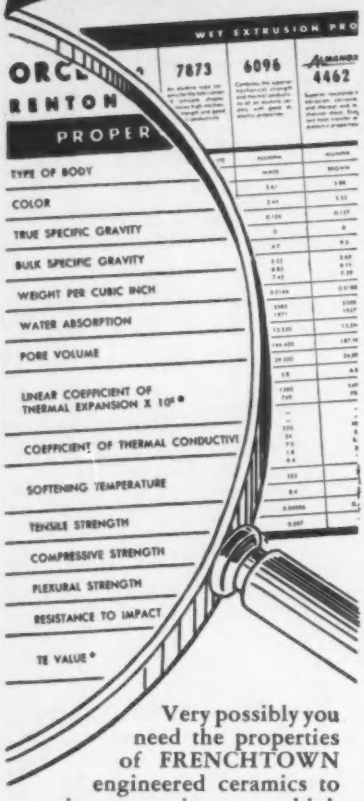
The line pressure working against the cross-sectional area of a newly introduced angle valve's plug is cancelled out by means of a drilled hole along the axis of the plug, intersecting radially drilled holes near the top. Thus, the line pressure is transmitted through this passage and exerts a downward force on the plug equal to the upward force. As a result the valve may be positioned accurately at pressure differentials as high as 3,600 psi with standard superstructures actuated by standard instrument air output.

With the plug on its seat, the line fluid would normally tend to flow through the space between the plug and guide and continue through the drilled passage to the downstream side. This is prevented by interposing a seal


ELECTRICAL
CORDS
KEEP YOUR APPLIANCES
IN SERVICE
Belden
MANUFACTURERS AND SERVICE MEN WHO SERVE BEST
Specify Belden
WIREMAKER FOR INDUSTRY

# Have You Taken a Good Look Lately at...

## ENGINEERED CERAMICS?




**Very possibly you need the properties of FRENCHTOWN engineered ceramics to give you resistance to high temperatures and low thermal expansion; excellent mechanical strength and wear resistance; superior dielectric strength at both high and low frequencies.**

**Why not send for this chart showing electrical and mechanical characteristics of FRENCHTOWN high-performance ceramic bodies. Name your problem; we'll also send test samples.**

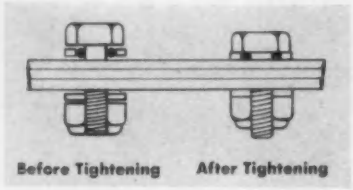
Frenchtown
PORCELAIN COMPANY
87 Muirhead Ave. . . . Trenton 9, N.J.




around the plug near the top of the guide. Made of an inert, frictionless plastic, this seal requires no attention or maintenance and is completely resistant to corrosion or chemical attack.

The valves are manufactured in sizes from 1 to 8 in., with body ratings from 150 to 1,500 lb ASA standard at a temperature rating of 450 F.

*Hammel-Dahl Co.,*
*175 Post Road, Providence 5, R. I.*

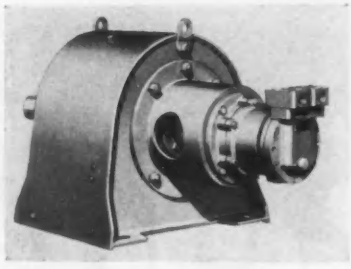



## One-Piece Seal Ring and Washer

A one-piece washer and rubber "O"-ring combination, with the "O" ring permanently bonded to the washer is now available in $\frac{3}{16}$ to $\frac{5}{8}$ in. nominal bolt diameters. They may be used to seal fluids, gases or air. They are for use around bolts where they go through walls, bulkheads or skins.

These seals are colored-coded according to use. The sealing materials are impervious to atmospheric elements, salt water, gasoline, oil and most organic solvents. The permanently bonded, one-piece construction eliminates slippage of the "O"-ring during or after installation. When the bolt is tightened the original round contour of the "O"-ring becomes square under compression.

*Rubber Teck, Inc.,* 19115 *S. Hamilton St., Gardena, Calif.*



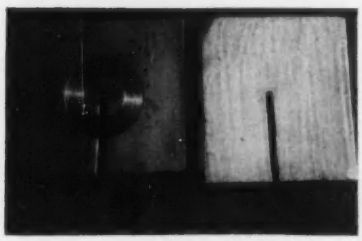
## Variable Speed Drives

Fluid power, constant displacement, axial piston motors and a complete line of concentric and right-angle, all-steel reducers are combined into a new line of integral variable speed drives. Motor sizes of 1, 3, 8, 12 and 20 hp are flanged and resilient coupling connected to single, double, triple and quadruple reducers, with ratio combinations providing maximum output speeds from 1.7 rpm to 1170 rpm. Normally continuous operation output torques ranging from 42 to 41,500 lb-in. are based on a pressure of 1100 psi. Starting and peak torques for intermittent service can be up to 60 percent higher.

Similar concentric variable speed drives with improved oil-tight shaft seals are available for vertical wall mounting and with roundface flanges for floor mounting. Units with single or double right-angle output shafts are available in ratios from 5:1 to 1500:1.

When used in combination with variable delivery pumps (input units), these drive assemblies are said to provide accurate speed regulation over the entire range, an infinite speed range (stepless), cushioned and controlled acceleration, quick reversal, constant torque over entire range, hydrodynamic braking, continuous service on reversing, starting, stopping and frequent speed change applications, safe operation in hazardous locations and automatic protection against overload.

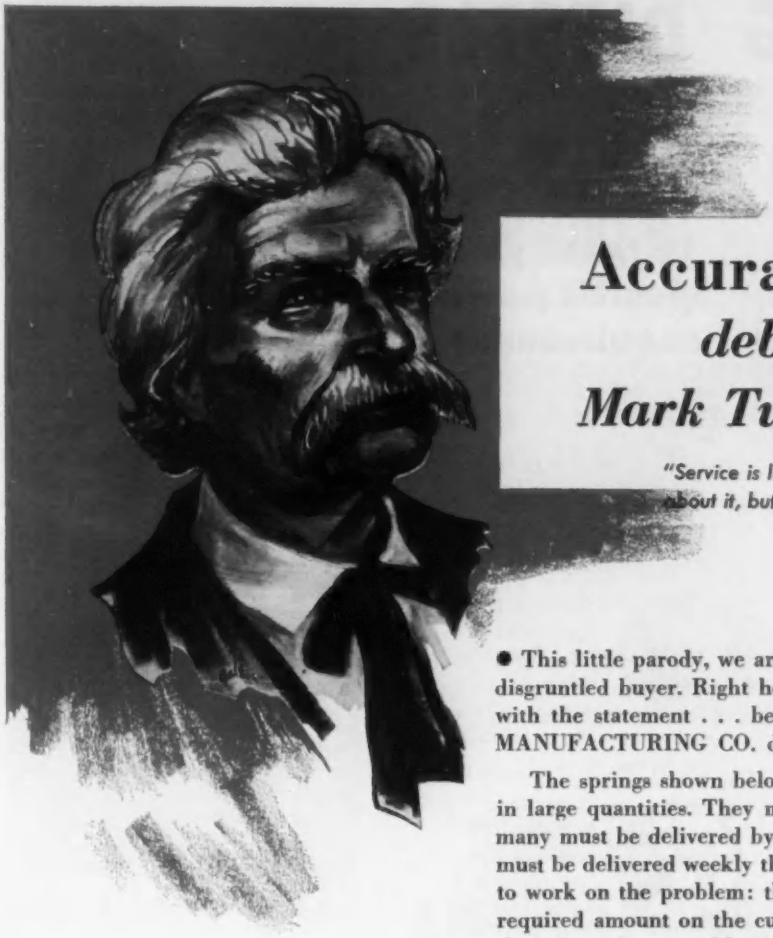
*Oilgear Co.,* 15786 *W. Pierce St., Milwaukee 4, Wis.*



## Hard-Surfacing Applied With A Paint Brush

A new kind of metal-cladding which can be applied to any surface at room temperature is said to impart to the chosen substrata a hardness and abrasion-resistance almost equal to metallic tungsten. It is said to be self-lubricating as well. Metallic tungsten of near-colloidal particle size is suspended in a new type of extremely hard liquid plastic. Incorporated in the mixture is a hardening form of molybdenum disulfide.

This new hard-surfacing agent is now being tested in such applications as reducing the wear and extending the life of relay-latching members



# Accurate Spring *debunks a Mark Twain Parody*

*"Service is like the weather, everybody talks about it, but no one does anything about it."*

with apologies to Samuel Clemens

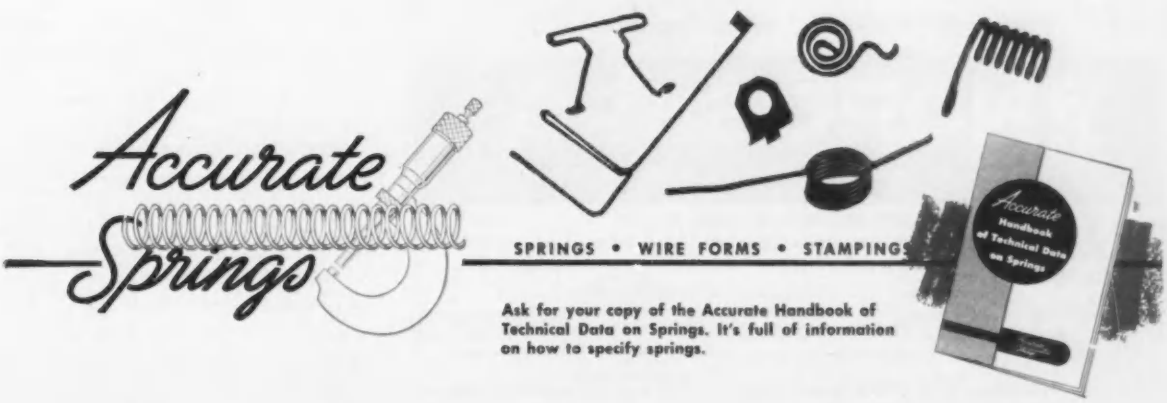
● This little parody, we are sure, was originated by some disgruntled buyer. Right here we wish to take issue with the statement . . . because ACCURATE SPRING MANUFACTURING CO. does do something about service.

The springs shown below were ordered by a customer in large quantities. They must be held to close tolerances, so many must be delivered by a specified date and so many must be delivered weekly thereafter. Accurate engineers went to work on the problem: the day of delivery saw the required amount on the customers' receiving platform and there have been weekly deliveries since.

The incident above is one of many where Accurate Spring has proved their service is just more than "talk." One of the basic principles of our business is *service* . . . the other is a quality product.

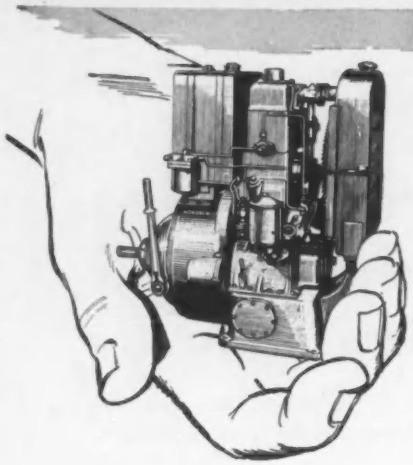
There is only one way to prove to yourself this isn't just more "talk." That's a chance for us to show you what we mean by Accurate service and Accurate quality springs. Write today . . . and let us prove it!

**ACCURATE SPRING MANUFACTURING COMPANY**
**3815 West Lake Street • Chicago, Illinois**




**Ask for your copy of the Accurate Handbook of Technical Data on Springs. It's full of information on how to specify springs.**

# NORDBERG DIESELS



*...engineered*
**to meet your specific power requirements**

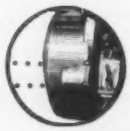
**SIZES FROM 10 TO 45 H.P. OR 6 TO 30 K.W.**

In the basic line of 1, 2, and 3-cylinder Nordberg "4FS" Diesel Engines, you have a choice of twelve *"standard"* power combinations—including electric generating units—straight power units—and centrifugal pumping units. In each one of these units you will find the design, performance, and over-all dependability that has made the name *Nordberg* the symbol of highest quality in the field of internal combustion power.

Of prime importance to design engineers, however, is the fact that the broad field of Nordberg experience is always available for engineering these basic Diesel engines to meet specific power requirements.

Let us help solve your power problem. *Mail the coupon for further data.*

***For 3 basic types of service:***



**ENGINES ONLY . . .** Your choice of 1, 2 and 3-cylinder units, with adapters for driving your equipment direct. Sizes from 10 to 45 hp.

**For MAIN or STANDBY ELECTRIC SERVICE...** Your choice of 1, 2 and 3-cylinder units, providing from 6 to 30 K.W. in Direct and Alternating Current—50 and 60 cycles.

**For CLUTCH-POWER TAKE-OFF . . .** Your choice of 1, 2 and 3-cylinder units, from 10 to 45 hp, with Twin-Disc clutch power take-off.

**NORDBERG MFG. CO., Milwaukee, Wisconsin**

NORDBERG MACHINERY
**NORDBERG**
*Builders of America's Largest Line of Heavy Duty Diesels*

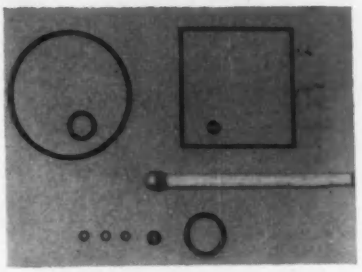
**MAIL THIS COUPON FOR DATA**

NORDBERG MFG. CO., Milwaukee, Wisconsin 4-154-PE
Send literature covering your "4FS" Diesel Engines. I am particularly interested in units for the following service:_____
Your Name_____ Title_____
Company_____
Address_____
City_____ Zone_____ State_____




in electronic computers, for surface-hardening and preventing dimensional losses by stylus-wear on cast phenolic masters in duplicating machines, eliminating grease lubrication and wear in bomb-fuses, in applications where a "case-hardening" effect is desired on brass, plastics and other softer materials. The illustration shows two pieces of brass against each of which a steel rod was rotated at 1775 rpm under 75 lb pressure. The brass square on the left was worn down to a depth of $\frac{1}{16}$ in., while the square on the right, subjected to the same treatment but protected with a coating of this new material, shows no wear, even on the coating.

*Lockrey Co., Southampton, N. Y.*



## Sub-Miniature Rubber Parts

Use of the injection molding process to produce sub-miniature "O"-rings and other microscopic rubber parts with a wide variety of industrial applications has made available parts as small 0.010 in. cross-section and 0.020 in. ID. The miniature parts have found applications in the manufacture of watch cases, butane gas lighters, electronic cables and water injection carburetor nozzles. Additional uses, according to the manufacturer, are in small switches and miniature air valves and controls.

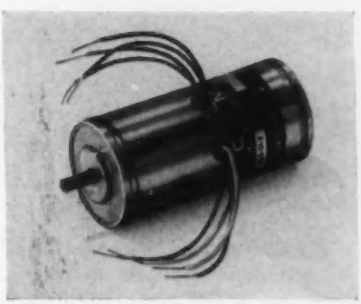
*Minnesota Rubber and Gasket Co., 3630 Wooddale Ave., Minneapolis 16, Minn.*

## Hermetically Sealed Miniature Connector

This new series of electronic circular connectors has a glass seal fused to the base of each contact and to the precision-machined steel body. According to the manufacturer, this improvement makes the new connector especially adaptable to missile-type

cabling, radar equipment and other applications where pressurized or vacuum-type equipment is used. The connectors are available with one to nine contacts, depending upon application. Positive indexing, plus a band lock which can be engaged by touch, assures simple and accurate joining of plug and receptacle under all conditions. This positive-acting lock also prevents uncoupling, even when subjected to severe vibration. The female section is equipped with hood and cable clamp. Both plug and receptacle contacts are gold-plated over silver, giving maximum conductivity, soldering ease, and resistance to corrosion. Current rating for all these connectors is 5 amp. Approximate weight of plug and connector is 0.57 oz.

*Viking Electric*, 1061 *Ingraham St., Los Angeles* 17, *Calif.*



## Servo Motor With Tachometer Generator

A small, lightweight motor generator for use in servo controls has its generator housed in the same case with the motor.

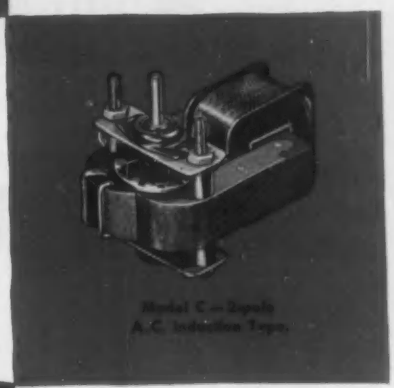
Weighing approximately 4 oz, the dual unit measure $\frac{13}{64}$-in. dia, $2\frac{5}{32}$-in. long. Both stators are completely embedded in an insulating compound of extreme dielectric strength and very high temperature stability. This material has a low coefficient of expansion and therefore great stability at high ambient temperature. Even at high

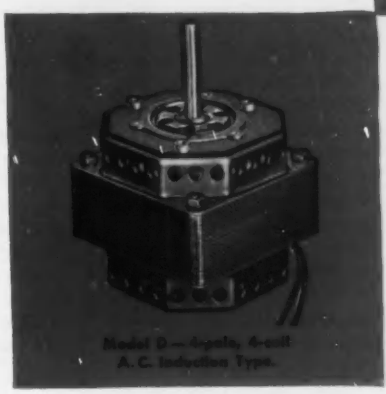

SMOOTH POWER

SMALL MOTORS

FOR ALL APPLICATIONS

(1/60th to 1/500th H.P.)





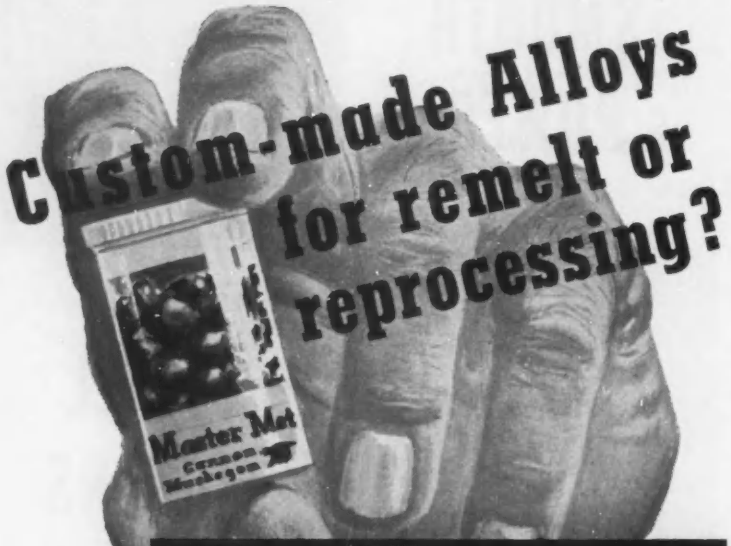
INCLUDING

Ventilating Fans
Dictating Machines
Room Circulators
Recording Instruments
Centrifugal Pumps
Remote Tuners
Bathroom Heaters
Vending Machines
Animated Signs
Automatic Record Changers

*Complete information, including specifications and dimensions will be mailed promptly upon request.*

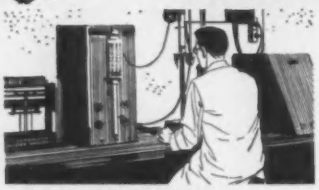
THE GENERAL INDUSTRIES CO.
DEPARTMENT MM • ELYRIA, OHIO

# Need pounds or tons of

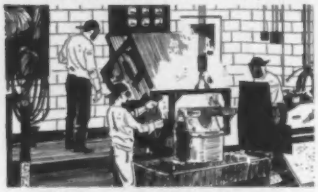



# Custom-made Alloys for remelt or reprocessing?

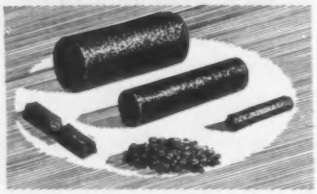
## Call on Cannon-Muskegon



Heats checked for chemical analysis.



High frequency induction furnaces.



Carried in stock are supplies of the 300 and 400 stainless steels as well as carbon alloys. "Specials" including electronic and aeronautical type alloys, tool steels, ferritic, austenitic and super stainless alloys of nickel- and cobalt-base. Available in shot, ingot, billet or cast bars.

**Exactly predictable metallurgical control of finished casting is assured by MasterMet control of high-temp alloys, tool, stainless, and carbon steels**

You specify the alloy — we'll tailor it to your needs, backed by a *certified* analysis! Name the quantity and the fast delivery will surprise you! Preparation can begin almost immediately after receipt of order. MasterMet "alloy tailoring" gives you all this:

**MATCHED ALLOYS TO YOUR MELTING PROGRAM** — Close control assures a constantly uniform melt. The results you get from a sample cast are the same as the final production run.

**MASTERMET CERTIFIED ANALYSIS**—Regularly furnished are notarized certificates insuring alloys that will cast to your exact production specifications.

**PRODUCTION MELTS OR SAMPLE JOBS** — A combination of test furnaces and larger multiple production furnaces assure completely flexible service at any time.

**FAST ACTION ON YOUR ORDERS** — No long delays for a mill run. Alloys delivered in drums, clearly marked with all specifications for fast selection and storage.

Write today for your copy of new MasterMet Alloy Bulletin for complete technical details.

**Cannon Muskegon CORPORATION**
MASTERMET
2877 Lincoln Street • Muskegon, Michigan

METALLURGICAL SPECIALISTS




altitudes great dielectric strength is maintained between windings and housing.

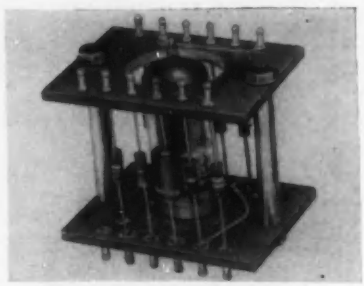
The maximum moment of inertia is 2.9 g $cm^2$. The motor is a two-phase unit with an input of 26 v per phase at 400 cycles; power input is 3.75 w per phase; stall torque is 0.35 oz in. and has a no-load speed of 6500 rpm. The generator provides an output of 0.32 v per 100 rpm. Maximum null voltage at 0.023 v. Units for other frequencies and voltages are available.

*G-M Laboratories, Inc., Dept. M, 4300 N. Knox Ave., Chicago 41, Ill.*

## Miniature Clutches

Four models of miniature clutches for over-running, backstopping, and indexing are now available. According to the manufacturer, the clutches have been standardized to provide small size clutches with high torque capacity, low price, long life and minimum maintenance. Standard bore sizes are $\frac{1}{4}$, $\frac{3}{8}$, and $\frac{1}{2}$ in.

*Formsprag Co., 23601 Hoover Road, Van Dyke, Mich.*

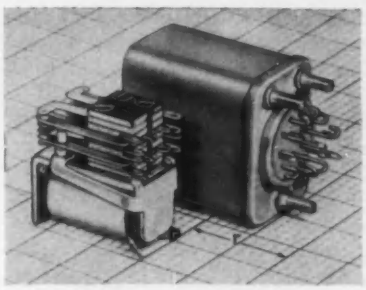


## Modular Mounting Units

Modular mountings are said to permit semi-automatic assembly of electronic equipment, using standard components without requiring costly or complex assembly set-ups. The glass-bonded mica insulation used in these units embodies mechanical and electrical properties characterized by low electrical loss factor, high dielectric strength and complete dimensional, heat and age stability. The accompanying illustration shows a two-stage high-fidelity pre-amplifier. The base plate is complete with molded-in tube socket and the printed circuit is fired. The top plate is complete with printed circuit and access hole for tube and tube shield. Standard components are

mounted in the base and top assembly and then all connections are dip-soldered. Units of this type are available in a variety of sizes and can be molded or fabricated to individual requirements. The unit shown is 2 x 2½ x 2½ in. Terminals permit plugging into a printed circuit plate used to integrate other modular mounting units into a complete assembly.

*Mycalex Corp. of America, Clifton, N. J.*



## Sub-Miniature Relay For Limited Space

Development of an ultra-small, subminiature d-c relay, designated as "Class 33," to meet requirements for applications involving operation in limited space has been announced.

The open-type model is only 1$\frac{11}{32}$-in. long, $\frac{11}{16}$-in. wide and 1-in. high. Hermetically sealed base dimensions are $\frac{31}{32}$ x 1$\frac{11}{32}$ in., height, 1$\frac{11}{64}$ in., with 14-pin solder terminal header and 6 contact springs per stack, 12 springs total per relay.

Despite the small size, accuracy and reliability are said to have been retained within the recommended range of application. The new relay features the same well-proportioned magnetic structure that has proved successful in other relays by the same maker.

The unit is expected to be able to meet military specifications for shock and vibration and to withstand wide temperature variations. It is furnished for any voltage to 110 d-c.

*Magnecraft Electric Co., 1442-P W. Van Buren St., Chicago 7, Ill.*

## Explosion-Proof Motors

Maximum ratings available in this manufacturer's line of horizontal, totally-enclosed and explosion-proof motors have just been increased to 150 hp. The totally enclosed model is


# how 10 characteristics of GAST rotary AIR MOTORS solve tough original equipment problems

Many a knotty power problem has been solved with Gast rotary Compressed Air Motors. Just one of these ten inherent advantages may make them ideal for your original equipment applications.

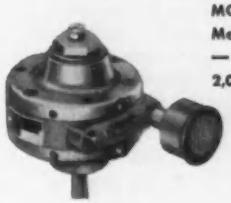
1 Much lower first cost.
2 Explosion-proof safety.
3 Variable speed over a wide range.
4 Can't burn out from over-loads or stalling.
5 Four vanes assure instant starting.
6 Amazing compactness for HP delivered.
7 Light weight—down to ¼ of equal electric motor.
8 Smooth-running rotary-vane performance.
9 Reversible models provide extra adaptability.
10 Dependability for long service—little maintenance.

Now standard equipment on such products as conveyors, hoists, agitators, textile machines, hose reels, liquid pump drives, etc., these versatile motors are available in four sizes and many design variations for vertical or horizontal drives with base or flange mountings.

**INVESTIGATE NOW**—Gast engineers will gladly cooperate in arranging for tests on your application.

MODEL 1AM Air Motor with silencer —to ⅛ HP rec., to 6,000 RPM. Only 2½" x 4¼", weighs only 1½ lbs.

MODEL 4AM Air Motor with foot—to 1 HP, to 2,000 RPM. Only 5¾" high less muffler. Weighs approx. 8 lbs.



MODEL 2AM Air Motor with muffler — to ½ HP, to 2,000 RPM. Only 5½" high. Weighs approx. 5½ lbs.

MODEL 8AM Air Motor with base, — to 4 HP, to 1,300 RPM. Only 6½" high, less muffler, 8¼" long. Weighs 25 lbs.

*Original Equipment Manufacturers for Over 25 Years*

GAST ROTARY AIR MOTORS · COMPRESSORS · VACUUM PUMPS
(TO 4 H.P.) (TO 30 LBS.) (TO 28 INCHES)
GAST MANUFACTURING CORP., 139 Hinkley St., Benton Harbor, Mich.

DIAPHRAGM OPERATED CONTROL VALVE WITH

***Full Port Diameter***

AND

***4-Position Indexing***

- Also applicable wherever desireable to control line flow by use of independent pressure on the diaphragm. Type D-53 is finding wide acceptance in substitution for expensive Solenoid Valves.
- Full port means high capacity. All bronze housing. Renewable chrome plated valve seat and composition seat disc. Neoprene nylon diaphragm. Also available with adjustable maximum and/or minimum flow limit stops.
- **For additional information on Type D-53, and other new automatic valves in the Cash-Acme line, write our Engineering Department at the address below. To avoid delay, please include a brief outline of your pressure conditions and requirements.**

This new pressure operated valve is offered in two basic types . . . either normally open and *closed* by diaphragm pressure or normally closed, and *opened* by diaphragm pressure. Typical use is on water cooled compressors.

Type D-53 may be used to handle water, air, oil or any non-corrosive fluids. Maximum body pressure 250 psig; diaphragm pressure 300 psig. For maximum hookup flexibility, the diaphragm pressure connection on this new Cash Acme valve may be indexed to any of the following four positions:

**1. Over inlet** **2. Over Outlet**
**3. Right Side** **4. Left Side**

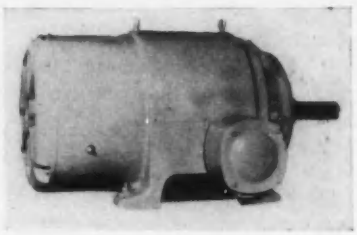
CASH ACME A. W. CASH VALVE MANUFACTURING CORP.

6627 E. Wabash Avenue Decatur, Illinois

The Complete Cash-Acme Line Includes Pressure Reducing and Regulating Valves, Relief Valves, Back Pressure Valves, Vacuum Regulators and Vacuum Breakers, Differential Pressure Regulators, Strainers, Diaphragm Control Valves.

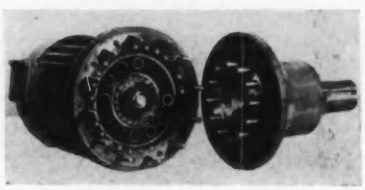
1—1-54



designed for protection against dirt, moisture, oil and chemicals. The explosion-proof motors are designed for service where inflammable gases, volatile liquids or combustible dusts may be present. This latter group of motors are supplied with the UL label for Class I—Group D, and Class II—Groups F and G. Both types of motors are double-enclosed with a built-in fan for full ventilation and greater heat dissipation. Windings are protected with asbestos to withstand high temperatures. Stator cover plate can be easily removed for inspection or cleaning. The rotor is made of cast aluminum, dynamically balanced. Bearings can be lubricated without disassembly. The full range of sizes in which these motors are now available is from $\frac{1}{3}$ to 150 hp. They can also be supplied in combination with variable drives when variable speeds are desired, or with a geared multiplied torque.

*U. S. Electrical Motors Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.*



## Reducer Without Conventional Gears

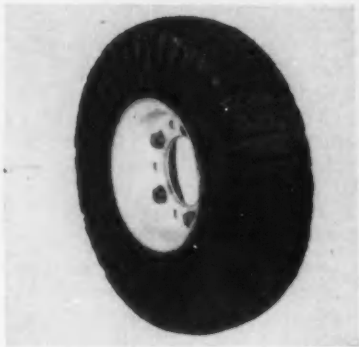
A reduction gear has been introduced that employs no conventional gears. In contrast to ordinary gearing, it works without any sliding contact and permits gear ratios as high as 71:1 in one stage. A two-stage gear can thus provide a speed reduction of about 5000:1. Even in these high ratios the new reduction unit is said to have an efficiency of over 90 percent.

The new unit is very compact and features a concentric arrangement. It is particularly suitable for mounting directly on motor shafts or for integral

arrangement with compact machinery. The gear ratio is positive. The high-speed shaft may run at several thousand revolutions per minute.

These gears have been running for several years in continuous 24 hr service without requiring maintenance except occasional renewal of the lubricant. Due to the high efficiency and absence of sliding contact, it is possible to use grease lubrication, thus eliminating the need for oil pumps or oil coolers.

*Ore & Chemical Corp., 80 Broad St., New York 4, N. Y.*



## Tubeless Tires for Materials Handling Equipment

A new industrial tire for materials handling equipment prevents punctures and blow-outs by eliminating tubes. These tires are constructed of highest quality rubber and fabric pads, fastened together under extreme pressure with an internal steel core. This forms a highly resilient tire with caterpillar tread which is said to give superior traction, high load capacity, easy and accurate steering.

These new tires are available in all popular sizes, within the major categories: regular, mine and lumber.

*Mitchell Industrial Tire Co., Inc., P. O. Box 468, Chattanooga, Tenn.*

## Vibration-Sensitive Switch

This instrument may be used for occasional vibration measurements or in a permanent installation as a protective monitoring switch to actuate a warning or shut down a machine when the vibration exceeds the normal value by a preadjusted amount. Flat response from zero to above 200 cps permits


OILITE®
*Heavy-Duty, Oil-Cushion Bronze*
BEARINGS
give you the performance you want PLUS many extras!

- Highest Factor of Safety
- No Inert Substances and No Graphite
  Made of 100% Virgin Materials
- More Than 25 Years' Experience
  *Developed World's First Heavy-Duty, Self-Lubricating Bearings*
- Every Application Engineered
- More Than 4,000 Engineers
- Field Engineers for On-the-Spot Service
  Depots Throughout U.S.A. and Canada
- Continuous Research and Development

*Only Amplex makes OILITE®*

Get better acquainted with OILITE Products.
Let us mail you our Bulletin S-53.

**CHRYSLER CORPORATION**
**AMPLEX DIVISION**
Dept. F Detroit 31, Michigan

OILITE PRODUCTS include: Bearings, Finished Machine Parts, Cored and Solid Bars, Permanent Filters and Special Units of Non-Ferrous and Ferrous Metals and Alloys.

In addition to supplying wire cloth in bulk, a fast-growing division of our company specializes in the fabrication or assembly of parts made from wire cloth. Many companies who formerly fabricated their own mesh parts now avail themselves of this service. After all, we know wire cloth—we've been making it for more than 75 years. We have the facilities, the skilled help, and the experience necessary to turn out these parts accurately and in small lots or in production quantities to meet your production schedules.

Some of our recent jobs are illustrated above. Perhaps one or more of these comes close to something you're working on right now. Write us giving complete details and specifications. If desired our experienced engineers will work with yours in the design of the part so as to make the most effective and economical use of the wire cloth. We shall be happy to quote on your requirements.

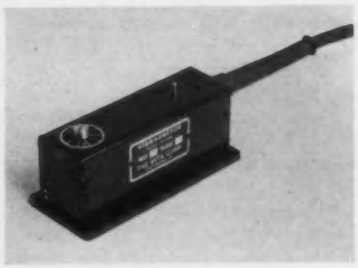
NEWARK for ACCURACY

We can furnish wire cloth woven from all commercially used metals. Sizes range from 4 inches (space cloth) to 400 mesh.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY



use of the device on almost all types of rotating or vibrating equipment including compressors, turbines, textile machines, machine tools and gasoline or diesel engines.

An internal single pole, double throw switch can be manually reset and may be used to control circuits of up to 5 amp with vibratory displacement increases of as low as 10 microinches at 12,000 rpm. Range is 0 to 2 G or 0 to 800 in. per sec with an accuracy of $\pm 0.05$ G. A less sensitive model may be used on machines subject to larger vibratory displacements or in aircraft to indicate when the maximum "G" load has been exceeded.

*Beta Corp., P. O. Box 8625, Richmond 26, Va.*

## Molded Valves of Polyvinyl Chloride

Molded, globe-type, polyvinyl chloride valves with stems may be repacked even under full line pressure, according to the manufacturer. No packing of any type is needed at the valve seat and the disc is easily replaceable. The 1-in. valve has been repeatedly tested at 1500 psi and operates a working pressure of 150 psi at room tempera-

ture. This product is corrosion-resistant and is expected to prove applicable in the chemical, petroleum, rayon, plating and allied industries in places where pressures are medium and temperatures do not exceed 160 F. The new valves are made to fit pipe sizes of ½, 1 and 1½ in. while maintaining full flow characteristics.

*Stokes Molded Products, Trenton 4 ,N. J.*

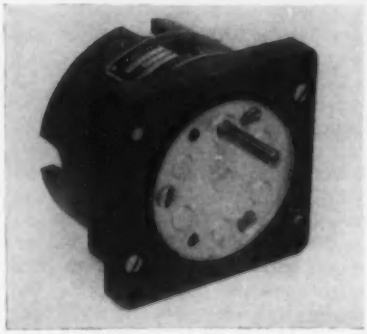
## Lightweight Sump Pump Motor

A sump-pump motor, 25 percent lighter than previous models, has aluminum end shields, cast aluminum rotor and welded steel shell for maximum strength. Insulated windings plus slot and between-phase insulation of polyester film provide extra protection against humidity and cellar dampness. The entire stator assembly is protected by a dip-coat of water- and heat-resistant varnish.

Meeting NEMA standards for sump pumps and cellar drainers, the new open drip-proof motor, type KH (split phase), is equipped with drip-cover, built-in switch and bottom flange for direct mounting. Weight or float switches are optional.

Rated at ⅓ hp, the motor is available in 50 cycle-1425 rpm and 60 cycle-1725 rpm models, and 115-230 volts.

*General Purpose Component Motor Dept., General Electric Co., Schenectady 5, N. Y.*



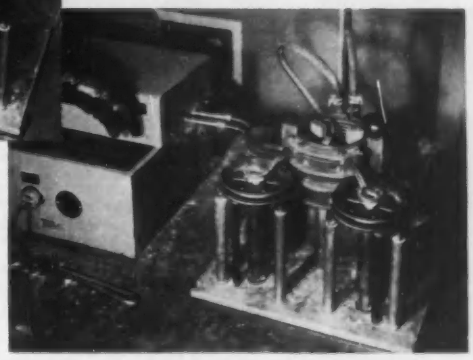
## High-Precision Gear Boxes For Servo-Mechanisms And Computers

Virtually friction-free and backlash-proof, these new gear boxes are available in speed ratios ranging from 20 to 1 up to 3125 to 1. Now in wide use on flight simulators, the gear

*Brazing with the low-temperature silver alloys EASY-FLO and SIL-FOS, supplemented by a fast heating method, and a set-up that promotes fast handling* — that's the ABC of economical metal joining. An effective example is the job pictured, courtesy of Zatko Metal Products Co. of Euclid, Ohio, large-scale manufacturer of stamped one-piece pulleys.

❶ One girl slips pulleys onto shafts and applies HANDY FLUX. The other puts a ring of EASY-FLO 45 wire on top of each assembly.

❷ Assemblies with preplaced alloy rings, are put in fixtures which accurately position pulleys, and are brazed automatically by induction heating.



❸ Heating time for 2 assemblies is 25 seconds. Production per 8-hour shift is 1500. Assemblies are tested to 4000-lb. pull.

**GET THE FULL *EASY-FLO* AND *SIL-FOS* STORY**

It's all in the profusely illustrated BULLETIN 20 — including useful pointers about joint design and fast, low-cost production methods. Write for a copy today.

HANDY & HARMAN
FOUNDED 1867
MANUFACTURERS OF EASY-FLO & SIL-FOS

**HANDY & HARMAN**

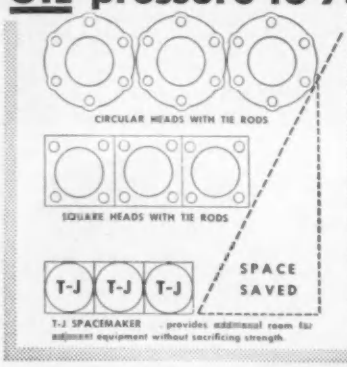
**General Offices: 82 Fulton St., New York 38, N. Y.**

**DISTRIBUTORS IN PRINCIPAL CITIES**

OFFICES and PLANTS
BRIDGEPORT, CONN.
PROVIDENCE, R. I.
CHICAGO, ILL.
CLEVELAND, OHIO
DETROIT, MICH.
LOS ANGELES, CALIF.
TORONTO, CANADA
MONTREAL, CANADA

T-J
Spacemaker
CYLINDERS

OIL pressure to 750—AIR to 200 P.S.I.




Now the sensational new T-J Spacemaker sets the pace in compact cylinder design and efficient performance!

New "Self-Aligning" adjustable oil cushion means faster acceleration and better cushion than ever before . . . New T-J Super Cushion Flexible Seals for air insure positive cushion with automatic valve action for fast return stroke.

*More plus features* include—heavy wall, precision honed, hard chrome plated, seamless steel body . . . leakproof cylinder head to body construction . . . heavy duty, high-tensile, *hard chrome plated piston rod.* Write for bulletin SM-454-2. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVITORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

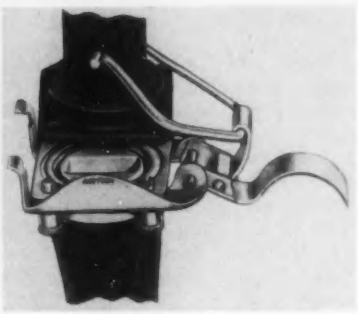



boxes have less than 0.01 in.-oz of frictional torque at the input shaft. Backlash at the slow shaft on gear boxes which operate at speeds of 500 to 1 has been rated at less than 0.27 deg.

Gears are aluminum and are lubricated for the life of the assembly. The resulting low inertia has been measured at 4.5 g $cm^2$ on a 500 to 1 gear box unit.

Life tests on models with a ratio of 150 to 1 revealed that they would function without stop for 1800 hr at 3000 rpm under 90 in.-oz of load without any difficulty. Similar tests on other units with high ratios indicated that long life and trouble-free operation can be expected from these assemblies.

*Link Aviation, Binghamton, N. Y.*



## Waveguide Flanges With Quick Disconnects

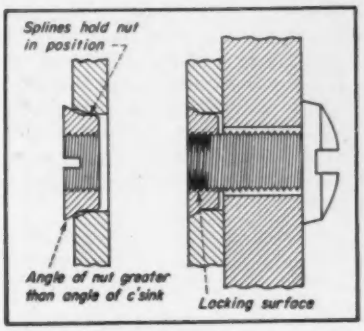
Disconnection fixtures have been developed which permit fast, positive decoupling of waveguide flanges without the use of tools, even under adverse conditions. The new units are particularly adaptable to airborne installations. It is stated that joints can conveniently be made while wearing gloves in cold, cramped quarters, where it would be impossible to decouple conventional flanges. Easy removal of waveguide sections that might otherwise impair refueling, gun loading or radar system maintenance is thereby afforded.

The fixtures are also useful in the field or laboratory, wherever speed or convenience is important. They can be readily operated even where only one side of the waveguide joint is accessible, and there are no loose parts that might be lost when the coupling is disconnected.

With the exception of four mounting studs and bolts, the fixtures are

fabricated entirely from stainless steel. They mount directly on the choke flange, becoming an integral part of the waveguide assembly. Since the choke flange threads are thereby used only once, the wearing down of soft aluminum threads is practically eliminated. These new couplings have been designed to fit waveguide sizes from 2.0 x 1.0 down to 0.360 x 0.220 OD. The fixtures are also designed to maintain pressurized joints up to 30 psi at —55 C, and will remain rf and pressure tight even under severe vibration.

*Airtron, Inc., Dept. A, 1103 West Elizabeth Ave., Linden, N. J.*




## Slotted and Splined Lock Nut

A new lock nut is a single, solid piece of metal—a slotted cone shape on one end, a splined cylinder on other. Designed to be inserted in a counter-sunk hole, the nut is partially or completely seated in material and is held in position by force-fitted splines. After bolt is inserted locking action is effected by the pressure of the sector threads forced against the bolt by the interference of the countersinks. Available in all metals and in all standard thread specifications.

*Allmetal Screw Products Co., Inc., 821 Stewart Ave., Garden City, Long Island, N. Y.*

## Indexer With Up To 500 Positions

A new speed indexer accurately indexes up to 500 positions, depending on the gear ratio and index plate ordered.

A self-contained shock control unit assures positive, fast indexing regardless of work-piece weight. Since this shock unit can be adjusted to meet varying loads it is claimed that maxi-

THE PRESIDENT GETS THE FACTS

**Farval has saved $16,982 in man hours, even more in production time**

WHEN 36 new metal-shaping presses were installed at an Indiana metalworking plant, management faced these facts: (1) It would take a whole squad of men to lubricate by hand. (2) Presses would have to shut down while the oilers worked. (3) Experience showed that the human element in hand lubrication would probably cause bearing trouble and heavy expense!

These facts led management to invest in Farval Centralized Lubrication. For a modest average cost of $295 for smaller presses to $1,164 for larger, Farval was installed to protect 1294 bearings.

In the four years these presses have operated at this plant, Farval has brought these benefits—benefits which Farval can bring to all machinery users: In man hours alone, Farval saved $16,982—the amount of wages which would have been paid to hand oilers. Farval also saved uncounted thousands of dollars in production time and thousands more in lubricant cost. No wonder Farval is widely used throughout this plant—on cranes, presses and other vital machinery.

FARVAL is the foolproof Dualine system of centralized lubrication that delivers a measured amount of clean lubricant at regular intervals to every bearing. From a central station, lubricant is pumped under pressure to a measuring valve at each bearing, delivering the exact amount of lubricant required.

FREE LUBRICATION SURVEY

Let us send one of our lubrication engineers to inspect your plant equipment. Without obligation, he will present a written analysis of what Farval can do for you. Write also for Bulletin 26 for the complete Farval story.

**The Farval Corporation**

3279 EAST 80th STREET • CLEVELAND 4, OHIO

*Farval is an affiliate of The Cleveland Worm & Gear Co., Represented in Canada by Peacock Brothers, Limited*

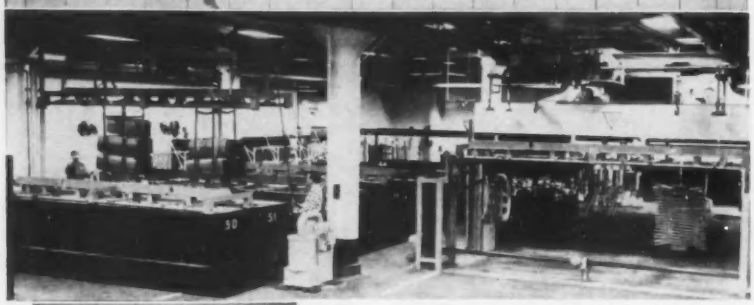
# USAF... *Martin* B-57's

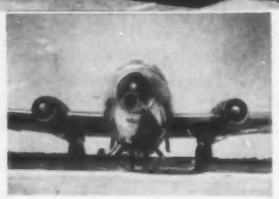
ARE

# *Alodized*

WITH ALODINE® No. 1200

## for EXTRA PROTECTION





View of a modern "Alodine" No. 1200 installation at the Glenn L. Martin Company plant, Baltimore, Md. In these dip tanks, aluminum components of the USAF B-57 (top) are protectively treated with American Chemical Paint Company's "Alodine" No. 1200.

Alodizing creates a durable bond for paint, and greatly enhances aluminum's natural corrosion resistance, particularly in salt air. Alodizing meets the requirements of Military Specification MIL-C-5541, and was adopted by Martin after a long test period.

***Pioneering Research and Development Since 1914***

**AMERICAN CHEMICAL PAINT COMPANY**

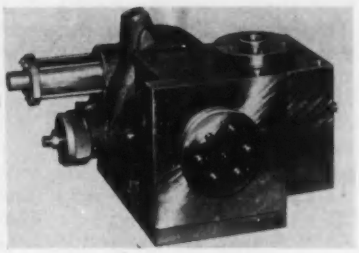
CHEMICALS ACP PROCESSES

**AMBLER, PA.**

CHEMICALS ACP PROCESSES

**DETROIT, MICH.** **NILES, CALIF.** **WINDSOR, ONT.**



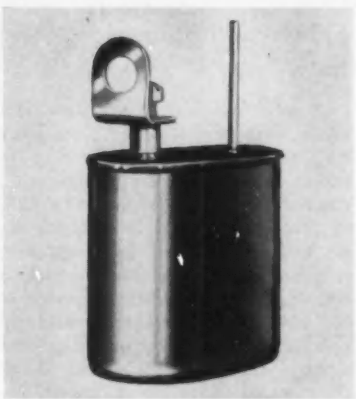



mum speed can be used without injury to mechanism or work. Over-ride is said to be completely eliminated. The hardened and ground index lock pin operates independently of actuating fluid.

Indexer gear box turns on the indexer spindle so the unit can be installed in four different positions for convenient work location. Operation is either by air or hydraulics. The drive spindle has a flange for convenient mounting of work-holding fixtures.

The new indexer is recommended for large quantity milling, drilling, tapping, welding and assembly operations where a considerable number of positions is required.

*Erickson Tool Co., 23 and Hamilton, Cleveland 14, Ohio*



## Hermetically Sealed Miniature Thermostat

This miniature thermostat is constructed to control non-inductive loads up to 5 amp at 27.5 v d-c. Rapid response and extreme stability are stated to be inherent in the design. Exposure to extreme temperatures between −100 F and 300 F does not alter the original calibration.

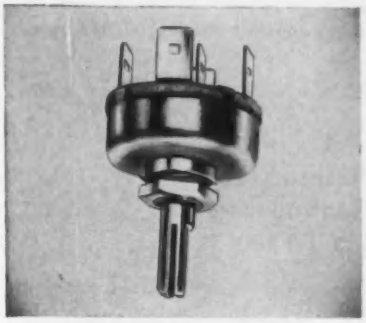
Extensive tests in crystal oven control indicate low temperature differential and very high stability.

Units are shipped precalibrated to specified operating degree and sealed. Non-calibrated units are also available

for calibration by customer. Size: overall $\frac{5}{16}$ in., $\frac{11}{16}$ in. wide, $\frac{7}{8}$ in. high.

Terminal and mounting arrangements are flexible and can be furnished from stock to meet any particular requirements. One terminal is grounded to case.

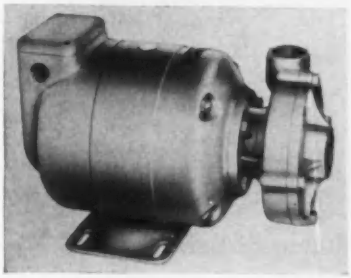
*George Ulanet Co.,*
*416 Market St., Newark 5, N. J.*



## Completely Enclosed Rotary Switch

This rotary snap switch is completely enclosed, for a variety of applications including fans, drink mixers, driers, ranges, washers and other appliances. The switch is listed by UL at 3 amp 125 v, dc. It is available in a large number of circuit sequences, including tap and accumulative positions. It is $1\frac{1}{8}$ in. dia and requires $\frac{3}{4}$ in. depth behind the mounting panel. Milled shafts are available, in any desired length. The switch is mounted by means of a $\frac{1}{4}$ in. threaded stem with a $\frac{3}{8}$-24 hex nut. The model can be supplied with screw, solder or special terminals, by its manufacturer.

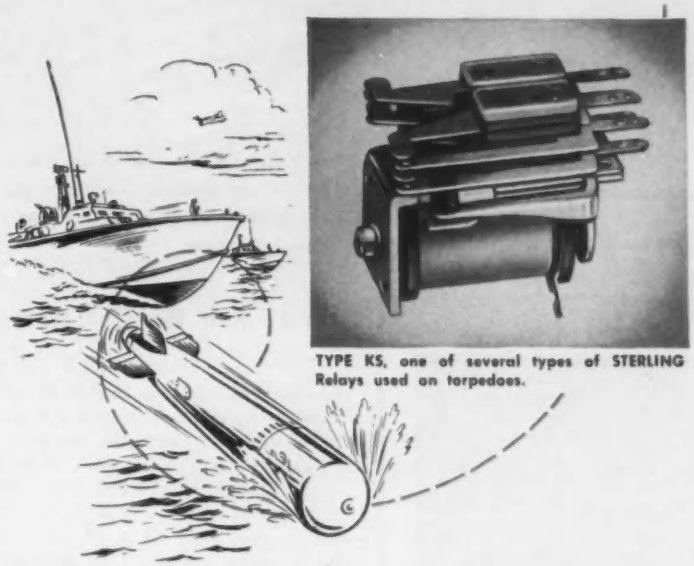
*Ark-Les Switch Corp.,*
*51 Water St., Watertown 72, Mass.*



## Directly-Connected, Motor-Driven Pump

A directly connected, motor-driven centrifugal pump is adaptable to various air conditioning instal'ations, in-


**From here to Eternity its mission depends on a STERLING RELAY!**



TYPE KS, one of several types of STERLING Relays used on torpedoes.

"FIRE ONE!" A torpedo leaps into the water. Now beyond human control, its own electro-mechanical "brain" takes over. And in that brain a small STERLING Relay plays a vital part!

Each torpedo gets only one chance to find its mark! When the alternatives are kill or be killed, who can calculate in American lives and ships the price of failure? . . . or measure fully the confidence placed in that tiny STERLING Relay? Because they have proved so rugged and thoroughly reliable in operation, standard types of STERLING Relays are used by every American torpedo manufacturer . . . and by many other leading manufacturers as well. You, too, can depend on STERLING Relays for *your* most critical circuits.

*General Specifications, STERLING Type KS Relay:*

**COIL—single wound up to 6500 ohms • SPRING ASSEMBLY—up to 6 springs in each of 2 pile-ups; wide choice of contacts • OPERATE TIME —.003 sec. min. • RELEASE TIME—.010 sec. max. • MOUNTING—two #5-40 tapped holes; also available with 2 or 4 mounting studs, tapped #4-40 (Mounting centers are ⅜" by 7/16") • DIMENSIONS—1½" x 1" x 1-7/16" max. • WEIGHT—approx. 1⅔ oz.**

May we send you the *new* STERLING RELAY CATALOG or make up a test relay for your particular requirements? Write STERLING ENGINEERING COMPANY, INC., 54 Mill St., Laconia, N. H. (Subsidiary of American Machine & Foundry Company, N. Y.)

Another AMF Product
Sterling RELAYS
Laconia, New Hampshire

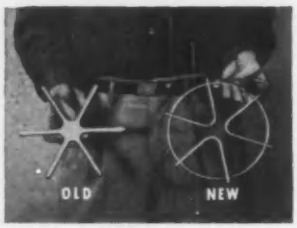
# "Simplicate it, and add more lightness!"

. . . The goal of modern industry — as expressed by one of America's greatest research engineers.

**That's the sole objective of the *Titchener Test:* To see whether a product—yours, for example—can be made simpler . . . lighter . . . cheaper.**

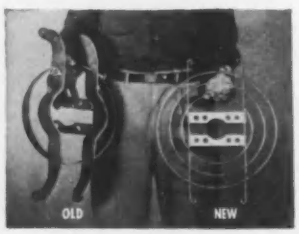
**"Simplicated" Case Histories**

Selected from among some 200 manufacturers who have taken the *Titchener Test* . . .




**Saves Manufacturer $4,015!**

Design of new portable stove submitted to Titchener called for die-cast burner grate. Tool cost for die casting quoted at $3,000 — estimated unit cost, 30¢. Titchener designed simple wire grate. Tool cost, $235; unit cost, 25¢. Savings on first order for 25M — $4,015.




**Wire Design Reduces Weight 75%**

The sheet steel motor mount shown at left was replaced by the Titchener-designed welded wire-and-strip assembly at right. Result: Weight reduced 75%. Costs reduced. Availability of material improved. Appearance much improved.

**Here's How The *TEST* Works**

Say the design of your product includes a casting or forging, stamping, tubing or sheet steel part. You send prints or a sample of the part to Titchener. A group of wire-forming engineers studies it from all angles . . . function, design, cost. If they find that wire can do a better job they'll submit drawings or a sample of the revised piece for your consideration. They'll also quote Titchener's low price for mass-producing the part. If they honestly feel wire can't improve your product, they'll tell you that, too.

The Titchener Test costs you nothing . . . imposes no obligation. It's unbiased and confidential. Merely send print or a sample . . . describe your wants in a covering letter.

**Send for *FREE* Handbook!**

**"Use of Wire Construction in Product Design"**

An illustrated 20-page technical handbook sent free to management, production, purchasing and engineering men. Write for your copy.

WIRE GOODS Headquarters

**E. H. TITCHENER & CO.**

67 Clinton St. Binghamton, N. Y.

Manufacturers of Wire Parts for Over 65 Years




cluding evaporative condensers, medium size cooling towers, fountains and swimming pools, requiring up to 40 gpm at a 30 ft head.

The unit has bronze fittings and will handle water and other liquids without danger of rust or corrosion, even where used intermittently and during seasonal idle periods. The unit is furnished with either ¼, ½ or ¾ hp motor.

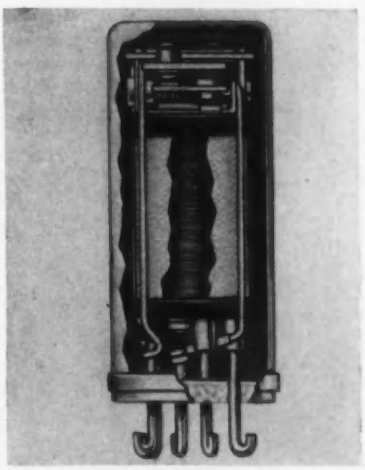
No additional mounting bracket is required as this pump can be installed either vertically or horizontally by using standard, integral NEMA motor base.

*Ruthman Machinery Co., Cincinnati 2, Ohio*

## Resistors For Continuous Heat Up To 100C

A new line of resistors designed to withstand continuous heat up to 100 C are completely encased in ceramic with axial lead mounting for easy connecting. Resistance and tolerance markings can be stamped on the ceramic for added convenience. Surpassing all military specifications, the new precision wire-wound resistors are available on request with glass, silicone or "Teflon" covered wire.

*Eastern Precision Resistor Corp., 130-11-90th Ave., Richmond Hill, N. Y.*



## Miniature Relay

A new, miniature, dc-actuated, hermetically sealed relay with ruggedized, balanced armature construction is being made that withstands 10G vibration up to 500 cps during operation. Needle-point pivot bearings afford friction-free movement and extremely long

life. Dimensions are 0.765 x 1.656 in. above chassis and weight is $1\frac{1}{16}$ ounce.

High permeability and a low residual nickel-iron magnetic structure gives high sensitivity and contact pressure that the manufacturer states has been previously unobtainable in a sensitive relay of this size.

Contact arrangement is 1 Form C (SPDT); contacts are $\frac{3}{32}$ in. dia pure silver, rated at 2 amp 28 v dc or 115 v, 60 cycles ac non-inductive load. Coil ranges are from 100 to 16,000 ohms; actuation, current or voltage; operating power, 25 milliwatts to 1.5 watt.

*Potter & Brumfield, Princeton, Ind.*

## Counter With Instantaneous Reset

An expansion of a line of mechanical reset counters, these new electric reset counters are available in four or five-digit models. Standard models have a counting speed of up to 10 impulses per second. Special models are available with speeds up to 25 impulses per second. Resetting to zero is accomplished in only 0.4 sec, and if necessary the reset voltage may be different from the impulse voltage.

The counters are suitable for flush mounting, and measure only $1\frac{3}{8}$ x $2\frac{3}{8}$ x $4\frac{3}{8}$ in. They are available with or without housings.

*Landis & Gyr, 45 W. 45 St., New York 36, N. Y.*

## Pressed Steel Housing Provides Low-Cost Ball Bearing Pillow Block

Low-cost ball-bearing pillow blocks with pressed steel housings have been designed for applications where speeds are relatively low and loads are light. Combining strength and light weight, the sturdy pressed steel housings are expected to permit a cost reduction

a special message for hardware manufacturers

need a finish for protection—decoration—identification? specify IRIDITE®

Specify Iridite . . . for corrosion protection during storage or use . . . for a firm and lasting base for paint . . . for extra quality and eye-appeal . . . for low cost color coding of finished parts.

**ON ZINC AND CADMIUM** you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.

**ON COPPER . . .** Iridite brightens copper, keeps it tarnish-free; also lets you drastically cut the cost of copper-chrome plating by reducing the need for buffing.

**ON ALUMINUM** Iridite gives you a choice of natural aluminum, a golden yellow or dye colored finishes. No special racks. No high temperatures. No long immersion. Process in bulk.

**ON MAGNESIUM** Iridite provides a highly protective film in deepening shades of brown. No boiling, elaborate cleaning or long immersions.

**AND IRIDITE IS EASY TO APPLY.** Goes on at room temperature by dip, brush or spray. No electrolysis. No special equipment. No exhausts. No specially trained operators. Single dip for basic coatings. Double dip for dye colors. The protective Iridite coating is not a superimposed film, cannot flake, chip or peel.

**WANT TO KNOW MORE? We'll gladly treat samples or send you complete data. Write direct or call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book.**

Iridite is approved under government specifications

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals, A.S.P. Plating Chemicals.
WEST COAST LICENSEE: L. H. Butcher Co.

# ANSWERS TO YOUR PUMP PROBLEMS

**CATALOG 101**—(Model L Series) Mechanically-sealed pumps in capacities from ½ to 6 g.p.m. and pressures to 600 p.s.i.

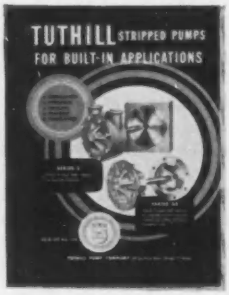
***These New TUTHILL Catalogs Give You Complete Data on Pumps for LUBRICATION, HYDRAULIC, COOLANT, TRANSFER and BURNING OILS SERVICE.***

**CATALOG 102**—(Model C Series) General purpose pumps in capacities from 2 to 200 g.p.m. and pressures to 100 p.s.i.

**CATALOG 103**—(Model CK Series) High pressure pumps in capacities from 5 to 200 g.p.m. and pressures to 400 p.s.i.

**CATALOG 104**—(Model M Series) Coolant pumps with automatic internal by-pass. Capacities from 2 to 50 g.p.m. and pressures to 15 p.s.i.

**CATALOG 105**—(Model R Series) Automatic reversing pumps in capacities from ¾ to 200 g.p.m. and pressures to 100 p.s.i.




**CATALOG 106**—(Types S and SA) Stripped pumps for built-in applications. Capacities from ½ to 200 g.p.m. and pressures to 100 p.s.i.

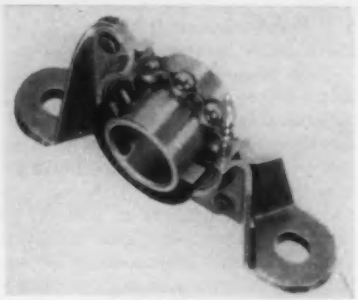
**CATALOG 107**—(Type SU) Multiple V-belt pumping units in capacities from 2 to 50 g.p.m. and pressures to 300 p.s.i.

Tuthill pumps are of the rotary, internal-gear, positive displacement type.
Any one or more of these Tuthill catalogs are available on request. They include individual pump guides to help you select the Tuthill pump best-suited to your requirements. Please ask for catalogs by number.

**TUTHILL PUMP COMPANY**
Dependable Rotary Pumps since 1927
939 East 95th Street, Chicago 19, Illinois

Canadian Affiliate—Ingersoll Machine & Tool Co., Ltd.
Ingersoll, Ontario, Canada



which should make them economical units for light-duty applications.

A precision, deep-groove, single-row ball bearing, self-aligning in all directions, assures smooth operation and long life. Free-rolling action and full load capacity are maintained even with minor shaft deflection or normal misalignment. A long inner ring distributes the load evenly over a large shaft area.

The new ball-bearing pillow blocks, "Series JPS-200," are available for shafts from ⅝ to 1¼ in. dia. They are easily installed by slipping the inner ring onto a shaft and locking it into position. Slotted bolt holes permit easy lateral adjustment.

A synthetic rubber lip-type seal, integral with the bearing, provides maximum sealing efficiency to retain the lubricant and to exclude dirt—even in extremely dusty and dirty locations. No further lubrication is necessary; the bearings are lubricated for life.

*Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill.*

## Dual Bank Counter For Plus and Minus Indication

This high-speed dual bank counter was developed for use in a navigating instrument. Its function is to indicate knots to right or left of course. The feature of having the two reading rows "in line" eliminates any possibility of error in reading on the "right" or "left" side of the indicator.

The shutter operates to close off either bank when it is in the minus side of its reading. The unit wheels of each counter row have 50 incre-

STAINLESS STEEL FOR TRANSPORTATION

# McLouth
## STAINLESS
# Steel

High quality stainless sheet and strip steel . . . for the product you make today and the product you plan for tomorrow.

**McLouth Steel Corporation**
**DETROIT, MICHIGAN**
*Manufacturers of Stainless and Carbon Steels*

# INDIANA GEAR

## *Aircraft specialists in...*

GEAR SHAPING
GEAR GRINDING
GEAR CUTTING
GEAR HOBBING
DRILL PRESS (RADIAL & POWER FED)
HORIZONTAL BORING
BROACHING
INTERNAL GRINDING
EXTERNAL GRINDING
LATHE WORK (TURRET & ENGINE)
HEAT TREATING
METALLURGY
ROTOBLAST
GUN DRILLING
MILLING
TAPPING
NITAL ETCH
AF APPROVED INSPECTION
ZYGLO
MAGNAFLUX
X-RAY EXAMINING
PARKO LUBRIZE
DICHROMATE
DULITE
COPPERPLATE
CADMIUM PLATE
VAPORBLAST
SPRAY PAINTING & BAKING
ASSEMBLY
DESIGN ENGINEERING

*Our complete facilities brochure available on request*

# INDIANA GEAR

**INDIANA GEAR WORKS, INC., INDIANAPOLIS 7, IND.**

**NEED MORE INFORMATION OR LITERATURE ON . . .**

. . Products Appearing in the Advertising Pages?

**WANT COPIES OF THE LATEST CATALOGS AND BULLETINS ON . . .**

. . Metals, Rubber, Plastics, Finishes?

. . Mechanisms, Instruments, Electrical Devices?

. . Hydraulic or Pneumatic Components, Motors, Controls?

. . Other Types of Equipment and Engineering Materials?

# READER SERVICE

KEEP UP TO DATE

Every month Product Engineering lists scores of new catalogs and bulletins available from manufacturers. Some of these cover features of specific equipment. Others contain detailed technical information on selection and application of broad classes of products. All are available to you for the asking.

**USE THIS CARD**

★ For copies of any manufacturers' bulletins described in this issue, circle postcard number.

★ For additional information on advertised products, fill in numbers of the pages on which products appear in spaces provided on postcards. If more than one product appears in the advertisement or if more than one advertisement appears on a page, indicate by name or initial the item in which you are interested. Write in name if pages are unnumbered.

**Product Engineering** Not good after 10/1/54

Please send complete information about the products advertised on the following pages:
(If more than one product is advertised on a page, indicate one in which you are interested. If no page number is indicated, write in name of advertiser.)

..... ..... ..... .....

..... ..... ..... .....

Send copies of the new bulletins and catalogs circled below to my attention.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72

Name..... Title.....

Company.....

Address..... 2/54

Product Engineering—A McGraw-Hill Publication

Postage Will be Paid by McGraw-Hill Pub. Co.

No Postage Stamp Necessary If Mailed in the United States

**BUSINESS REPLY CARD**

First Class Permit No. 64, (Sec. 34.9, P. L. & R.) New York, N. Y.

**Reader Service Manager**
**Product Engineering**
**330 West 42nd Street**
**New York 36, N. Y.**

# READER SERVICE

*...for your convenience in requesting new product catalogs and bulletins*

*...or further information on products advertised in this issue*

Postage Will be Paid by McGraw-Hill Pub. Co.

No Postage Stamp Necessary If Mailed in the United States

**BUSINESS REPLY CARD**

First Class Permit No. 64, (Sec. 34.9, P. L. & R.) New York, N. Y.

**Reader Service Manager**
**Product Engineering**
**330 West 42nd Street**
**New York 36, N. Y.**

**Product Engineering** Not good after 10/1/54

Please send complete information about the products advertised on the following pages:
(If more than one product is advertised on a page, indicate one in which you are interested. If no page number is indicated, write in name of advertiser.)

..... ..... ..... .....

..... ..... ..... .....

Send copies of the new bulletins and catalogs circled below to my attention.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72

Name.....Title.....

Company.....

Address..... 8/54

**Product Engineering—A McGraw-Hill Publication**

Getting all the information about all of the significant new developments in the design field every month is a tough . . . and time consuming . . . job. To save you time, the editors of Product Engineering screen scores of new catalogs and bulletins each month, select only the ones they know will be of interest to you, and summarize each for your convenience. The companies issuing these catalogs welcome your request for copies.

To save you time in making such requests, simply use one of the attached post cards.

For catalogs and bulletins, simply circle on the post card the numbers which correspond to those that accompany our editors' listings and descriptions. Our Reader Service Department will do the rest.

Also use this same card when you want additional information on any products advertised in this issue.

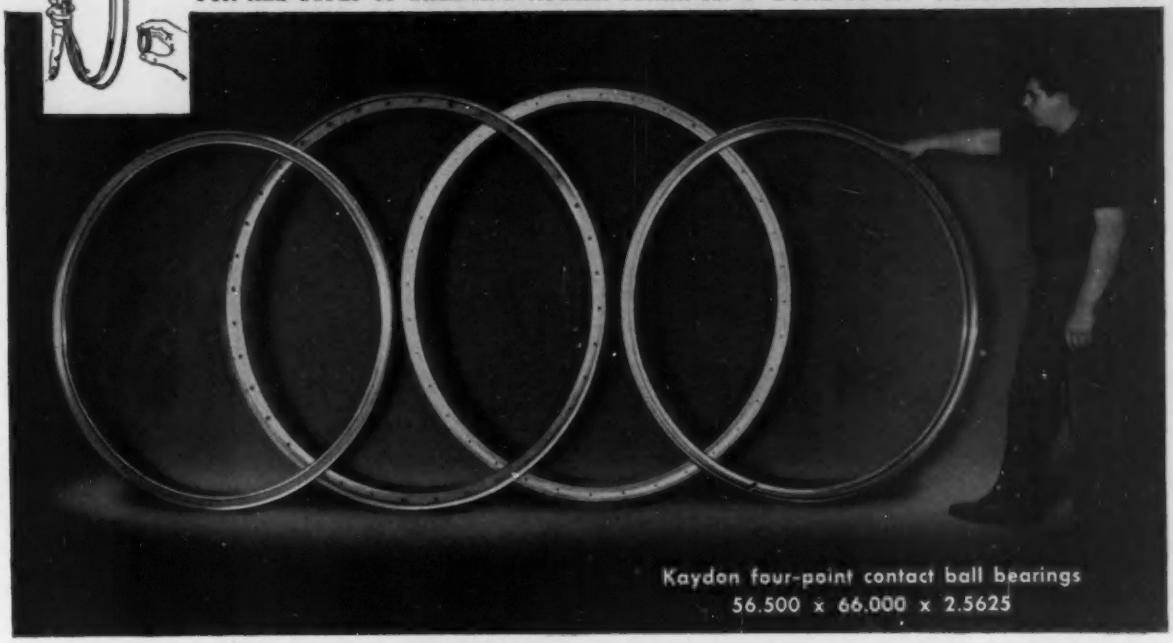
Just write, in the spaces provided, the numbers of the pages on which the products in which you are interested are advertised.

PLEASE USE ONE CARD ONLY . . . so that this service may also be available to other men in your company who may read this same copy of Product Engineering.

To be sure that your request will receive prompt and careful attention, please write or print legibly your name, company affiliation, and address. This service is valuable to you only if you use it. We welcome your comments and suggestions at any time.

Contact KAYDON Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER



Kaydon four-point contact ball bearings
56.500 x 66.000 x 2.5625

*Four-point contact ball bearings...*

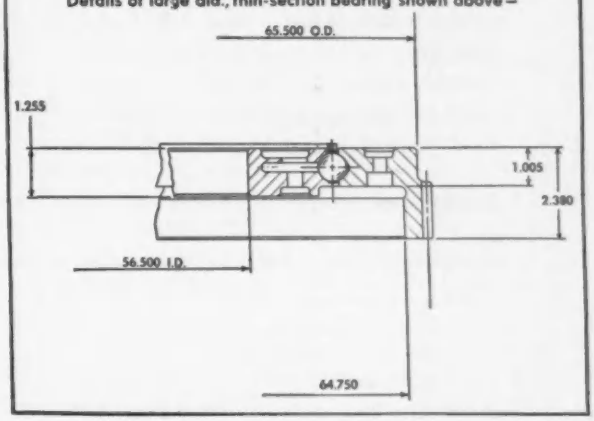
# Featherweights for heavy-duty applications — built by Kaydon

To keep a classified product's overall design within practical limits, a major manufacturer required special bearings. Specifications included: extremely thin section in relation to 66" O.D. . . . light weight . . . with integral gear teeth and strength to withstand constant, hard usage. Furthermore, the bearings would have to be mass-produced.

Knowing that KAYDON concentrates in design and production of special thin-section and/or high-precision bearings, the manufacturer got in touch with KAYDON sales engineers. In a short time the heavy-duty feather-weights, shown here, were developed to solve the problem.

Similarly, for special bearings you, too, can save time, money and trouble by contacting KAYDON of Muskegon.

Details of large dia., thin-section bearing shown above —



*Just Out! Get your copy of the new* KAYDON *Reali-Slim thin bearing catalog No. 54.*

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

K547

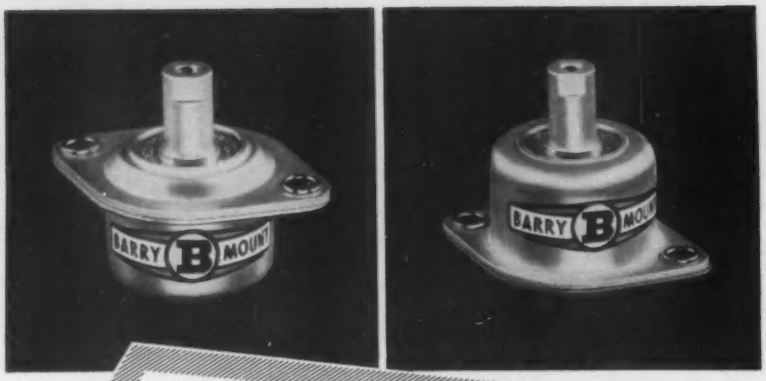
PRECISION BALL AND ROLLER BEARINGS

*the* **NEW** *miniature*

**...ALL-METL**

**BARRY B MOUNT**

UNITS SHOWN ACTUAL SIZE



*for all-temperature vibration protection of airborne equipment*

These new isolators are
the latest addition to the famous
Barry ALL-METL line.
They are specifically designed to help you meet miniaturization demands under toughest environmental conditions.

***Temperature range*** — from −60°C to +175°C
***Weight*** — only ½ ounce per unit isolator
***Height*** — only 1¼ " free, 25/32" bottomed
***Load ratings*** — 0.1 to 3.0 lbs. per unit isolator
***Performance*** — meet all relevant requirements of JAN-C-172A/MIL-C-172B
***Ruggedized*** — to meet shock tests under specifications AN-E-19, MIL-E-5272, MIL-T-5422B, and MIL-C-172B.
***Mounting styles*** — available in plate and cup types, as illustrated, for 2-hole or 4-hole mounting.

For complete information, ask for your free copy of the new Barry Product Bulletin 542, containing full installation and performance data. And for greatest benefits with these new isolators, let our Field Engineering Service help in the early stages of your equipment design.

THE **BARRY** CORP.

730 PLEASANT STREET
WATERTOWN 72, MASS.

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

*British Licensee: Cementation (Muffelite), Ltd., London, England*




ments which provide for extreme accuracy.

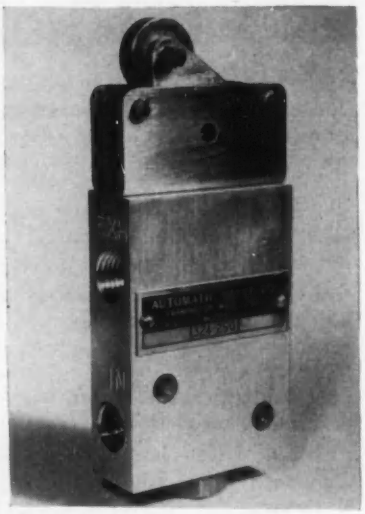
The wheels and pinions are equipped with oil-less bushings so as to provide for speeds up to 1400 rpm and a low torque of 0.8 in. oz. Materials are magnesium and aluminum in all components except gears, pinions and lock washers, which are hardened steel. Shafting is stainless steel. Overall dimensions of the unit are 3¼-in. long ¾-in. wide by 1.140-in. high.

*Durant Mfg. Co.*, 1938 *N. Buffum St., Milwaukee* 1, *Wis.*

## Open, Dry-Type Power Transformers

A new line of power transformers with ratings from ½ up to 100 kva are of the open-dry-type design and are available in single-phase and three-phase ratings. These transformers are designed for industrial applications such as power supply units and utility service. They are designed and built in accordance with AIEE, NEMA and ASA specifications.

*Perkin Engineering Corp.*, 345 *Kansas St., El Segundo, Calif.*



## Manually Operated Three-Way Pilot Valves

A new series of manually operated pilot valves for the operation of single-acting or spring-return cylinders and for operating large master valves, has been introduced.

These valves came in five models, operated by lever, roller cam, stud and

1 and 2-in. palm buttons. All models are available normally closed or normally open.

These valves are small, compact and of aluminum construction. They are used at standard pressures for controlling flow of compressed air and are also available for low-pressure hydraulic operation.

*Automatic Valve Co.,*
37415 *Grand River, Farmington, Mich.*

## Combination Switch and Starter

This selector switch and fph manual starter for air conditioning and heating equipment comes in a single, compact, diecast enclosure.

Installation costs are reduced because there is only a single device to be mounted and wired. The selector switch permits remote control from a thermostat, or local control from the starter. The manual starter provides motor overload protection.

Two manual starters, without the selector switch, are also available in the same enclosure. Maximum ratings are 1 hp at 115 or 230 v single-phase ac, or 115 or 230 volts dc.

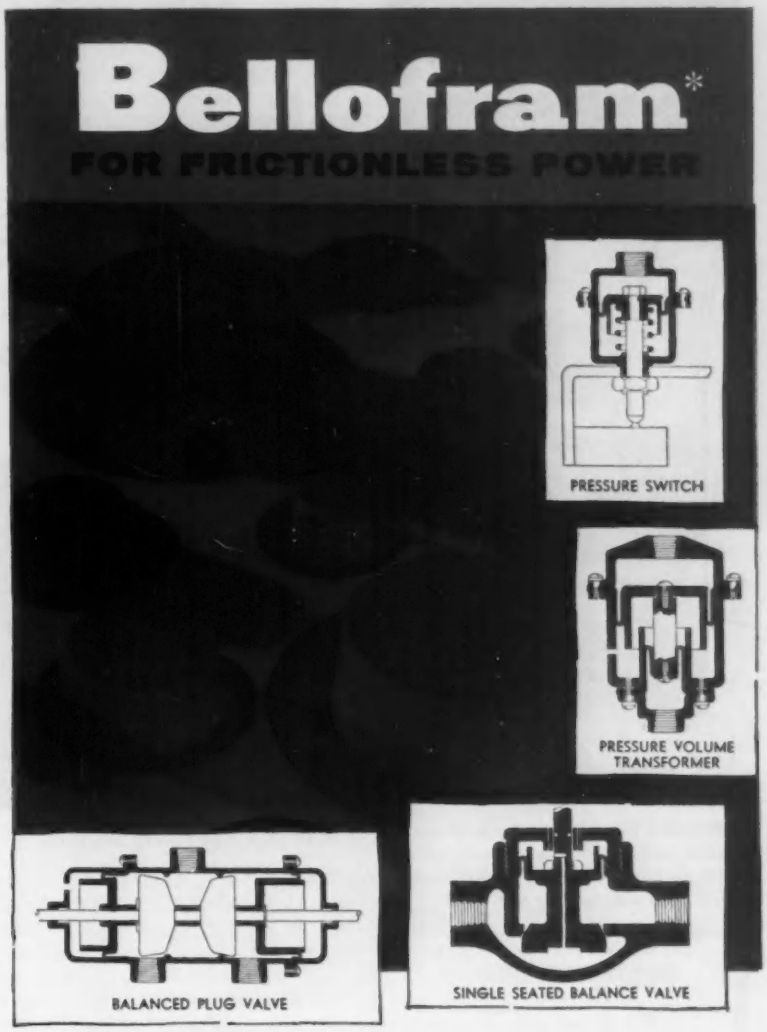
*Square D Co.,* 4041 *N. Richards St., Milwaukee* 12, *Wis.*

## Hermetically-Sealed Miniature Relay

A new hermetically-sealed, telephone-type relay has been announced which is $1\frac{5}{8}$ in. wide, $1\frac{7}{16}$ in. long and 2 in. high. The relay is classified as a midget type and its weight is only 6 oz.

Ample reserve power in the coil permits the relay to withstand high shock and vibration, making it applicable to aircraft and other transportation equipment. The relay meets the requirements of MIL-R-5757 or MIL-R-6106.

Standard contacts are palladium; silver contacts are available when speci-


**IN YOUR FLUID SYSTEMS**

When you combine "Bellows" with "Diaphragm" you get "Bellofram." This amazingly simple but new idea in Fluid Barriers performs both bellows and diaphragm functions — easier, better and simpler. A standard Bellofram can be applied to your product.

**WHAT THEY ARE**

*Bellofram* seals are long-stroke, deep convolution, constant-area diaphragms with extreme flexing life and exceptionally low spring gradient. They are relatively unaffected by foreign matter, and since they need no lubrication, they are clean. They eliminate leakage. Friction-free, rolling action gives exceptional cycle life. High dielectric strength and remarkable resistance to chemical action are important features. Area accuracy is affected only by surrounding components to which they automatically adapt themselves.

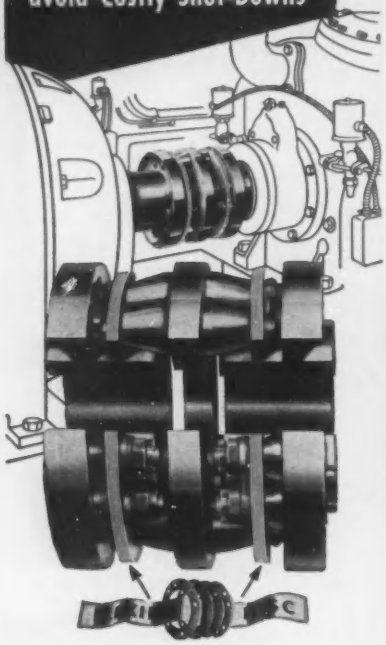
**APPLICATIONS UNLIMITED**

*Bellofram* seals may be used in almost any piston-cylinder application, for either precision measurement or frictionless power. Infrequent replacement is the only maintenance. Effective area can be controlled to within less than 0.1% over the working stroke. Efficient operation can be obtained at pressures varying from inches of water to 500 PSIG max. over a wide temperature range. Plan to incorporate Bellofram seals into both your old and new designs. A sketch of your device will help us help you. Strict confidence observed. Write today.

© Bellofram Corporation
* Trademark

Bellofram
CORPORATION
144 MOODY ST., WALTHAM, MASS.

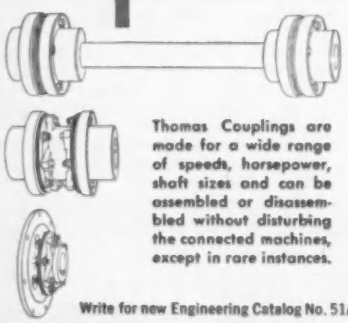
Specify THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

DISTINCTIVE ADVANTAGES

| FACTS | EXPLANATION |
|---|---|
| NO MAINTENANCE | Requires No Attention. Visual Inspection While Operating. |
| NO LUBRICATION | No Wearing Parts. Freedom from Shut-downs. |
| NO BACKLASH | No Loose Parts. All Parts Solidly Bolted. |
| CAN NOT "CREATE" THRUST | Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement. |
| PERMANENT TORSIONAL CHARACTERISTICS | Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained. |



Thomas Couplings are made for a wide range of speeds, horsepower, shaft sizes and can be assembled or disassembled without disturbing the connected machines, except in rare instances.

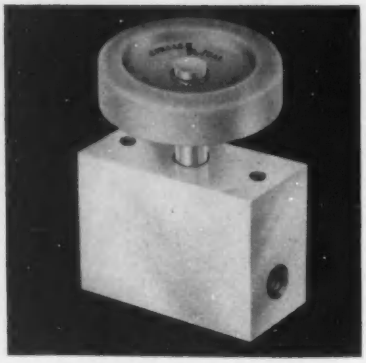
Write for new Engineering Catalog No. 51A

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.




fied. The standard contact model is rated at 2 amp, 115 v 60-cycle ac or 28 v, dc, non-inductive. With the silver contacts which are larger in size, the current rating is increased to 5 amp. The maximum switching combination is four poles, double throw. Either solder lug or plug-in terminals are furnished. Coils are available with resistance from 12 to 3600 ohms and for voltages from 6 to 115 v. Maximum power consumption is 4 w.

*Williams Mfg. Co.,*
4242 *Fillmore St., Chicago* 24, *Ill.*



## Manual Shut-Off Valves

Positive, leak-proof shut-off is the manufacturer's claim for this new series of valves. The O-Ring is withdrawn completely and automatically from the fluid stream as soon as the valve begins to open. Throttling is then accomplished by means of a conical metal plug, which varies the orifice area.

In principle, the valve is two valves: the shut-off section employing an O-Ring is drawn back into the throttling section when the valve is opened, both actions being accomplished in a single motion. No reversal or abrupt change in direction of flow takes place within the valve, thus assuring low pressure drop even when pressure and flow rate is high. Rated at 0 to 3,000 psi, the valves can be used in either hydraulic or pneumatic service.

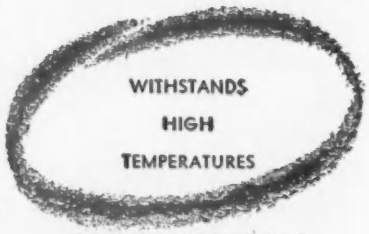
*Circle Seal Precision Valves,*
2181 *E. Foothill Blvd., Pasadena,* 8, *Calif.*

## Controls Level of Conductive Liquids

A new level control will control the level of any conductive liquid. It consists of an electron tube amplifier and relay combination which operates from minute currents in the probe


Durakool the
STANDARD
of Quality,
Durability and Life

Years of trouble-free performance on the most difficult of assignments have won top recognition for Durakool Mercury Tilt Switches. High temperatures, fast cycling and 24 hour schedules taken in stride. 7 sizes, 1 to 65 amperes. Send for Bulletin 525.




See telephone directory for local distributor or write

DURAKOOL, INC., Elkhart, Indiana

Durakool
ALL-STEEL MERCURY SWITCHES

circuit. Except for annual replacement of a long-life electron tube, it is described as being maintenance-free, as there are no floats or stuffing boxes to wear or fail in operation.

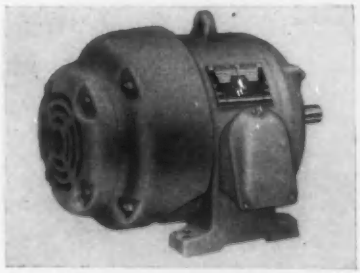
Contact with the liquid is made only by corrosion-resistant stainless steel probe rods. Accuracy is independent of temperature and pressure. A single control, through flexible terminal panel connections, provides for operation as either a pump-up or pump-down control, or a high or low-level safeguard with fail-safe action for all five types of operation. The control is universal for either 115 or 230 v, 50 to 60 cycle supply.

*Photoswitch Inc., 77 Broadway, Cambridge 43, Mass.*

## Pocket Comparators Directly Measures Small Dimensions

A new 1½-in.-dia pocket comparator with 6 magnifying lens measures angles, small diameters and radii, and microscopic lengths through a glass-inscribed reticle. Measurements of tool wear, chamfer angles, small part tolerances are made quickly on the "Indeco" without re-focusing.

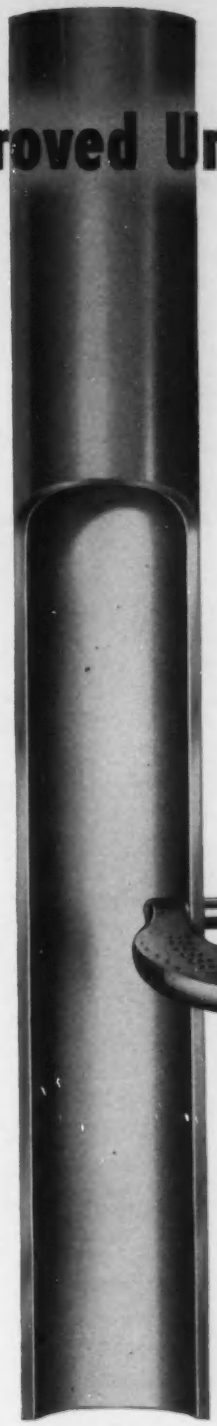
*International Development Co., 1 S. Reed St., East Riverton, N. J.*



## Totally Enclosed Constant Speed Electric Motors

Totally enclosed, fan-cooled, constant normal speed motors, in frame sizes 182 and 184, incorporate the new NEMA approved standards. More than 50 percent of the inactive space in previous designs has been eliminated, creating a smaller, more compact motor.

Larger bearings per horsepower rating are used, which are double shielded and pre-lubricated with extra grease reservoirs. A more rigid winding is

**Proved Under PUNISHMENT**

**STANDARD CYLINDER TUBING**

**"Mirror Finished" to precision tolerances, it's used in automobile shock absorbers, power steering, hydraulic pumps . . . without further sizing or finishing.**

Here's a busy part of an automobile shock absorber that's built for brutal punishment. It's Standard's modern "mirror-finish" Cylinder Tube. So that it won't weaken or leak under punishment, every inch of this tubular "toughie" must measure up to exacting specifications—in cylinder finish . . . in I.D. tolerances as close as .001" . . . in extreme uniformity of wall thickness and concentricity . . . in internal pressure resistance, to shocks up to 9000 P.S.I. The elimination of broaching or further processing of any kind effect significant savings for our customers in product assembly.

As you see here, the engineering involved behind the application of tubing to your product is *more than skin deep at Standard.* Our engineers will gladly show you why in helping you with your tubular application—whether it involves a simple structural or mechanical member . . . or a precision application.

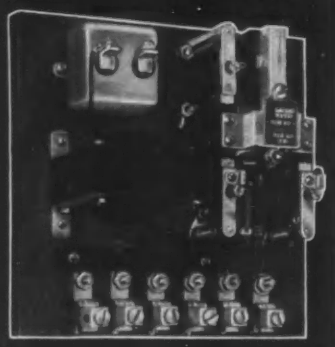
*Send for 8-page folder on all Standard products or see Sweet's Design Catalog.*

**MAKE "STANDARD" YOUR SOURCE FOR—**

- WELDED MECHANICAL TUBING
- WELDED STAINLESS TUBING
- BOILER AND HEAT EXCHANGER TUBING
- EXCLUSIVE "RIGIDIZED" PATTERNS

**STEEL TUBING SIZES: ½" O.D. TO 5½" O.D.—.028 TO .260 WALL.**
**STAINLESS SIZES: ¼" O.D. TO 4½" O.D.—.020 TO .154 WALL.**

ASCO
*current sensitive*
close-differential
relay



**process *control* by motor current *measurement***

**This Relay offers wide possibilities for automatic control problems. Why not investigate it for use with your process or equipment?**

- **2% SENSITIVITY**
- **CONTINUOUS DROP-OUT ADJUSTMENT**—with factory-set pickup. (Also designed with a continuous pickup adjustment.)
- **SUPPLIED IN ANY POLE COMBINATION**—to 2 normally open, 2 normally closed.
- **OPEN OR ENCLOSED**
- **ELECTRICAL RATINGS**—Contacts rated 5 amps Continuous Current, 600 Volts Maximum; Coils to 60 Amp. Capacity—higher when supplied with current transformers.
- **VOLTAGE-TYPE AVAILABLE**—comparable construction and operating characteristics.
- **SPECIAL MODIFICATIONS**—high shock designs, variable pickup, frequency response, delayed action, etc.

*Mixing a batch?*

Assume you have a batch mixing process where the viscosity increases progressively as the batch nears completion. The current drawn by the driving motor will increase with the viscosity. An ASCO Close-Differential Relay could be used to automatically open the motor control circuit at the exact batch viscosity desired. This would be accomplished by merely calibrating relay operation to the current corresponding to desired viscosity.

In general, this ASCO Relay can provide a triggering impulse or trip in systems designed to control innumerable operations where electric motors are the power source or where current variations occur. Such systems include devices for the control of polymerization, measurement of viscosity, regulation of flow, etc.

**when you can predict a current variable . . . consider an ASCO Close-Differential Relay for your automatic control.**

FOR COMPLETE INFORMATION—Send for our Publication 69R1 on ASCO CLOSE-DIFFERENTIAL RELAYS.

ASCO Solenoid VALVES

ASCO Electro-Magnetic CONTROLS

Automatic Switch Co.

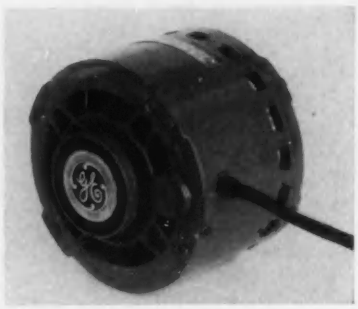
385-T Lakeside Avenue, Orange, N. J. • ORange 2-5300



provided and the inactive copper and copper losses decreased, giving more copper per horsepower and higher motor efficiency.

Diagonal cover type boxes that may be rotated 360° to be fixed in any desired position and have a tapped hole for conduit. The 182 and 184 frame sizes now available are the beginning of a complete changeover in this manufacturer's line to incorporate new NEMA standards.

*Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.*



## Heavy Duty FHP Motor

A new 5½ in. dia shaded-pole motor, designed for heavier duty at increased efficiency and low input current, has been announced.

The new "Type KSP-39" motor is available in ratings of $\frac{1}{12}$, $\frac{1}{10}$, $\frac{1}{8}$, and $\frac{1}{6}$ hp, for use in room air conditioners, furnace fans, unit heaters and coolers, window fans, and general fan and blower applications. It is an addition to its manufacturer's line of smaller shaded-pole motors, with ratings of 1.5 to $\frac{1}{10}$ hp. Optional features include internal baffling, single and double-shaft models, and resilient-base, cushion-ring, or shaft-end mounting.

To manufacture the new motor, a several-million dollar expansion and tooling program has been initiated by the maker.

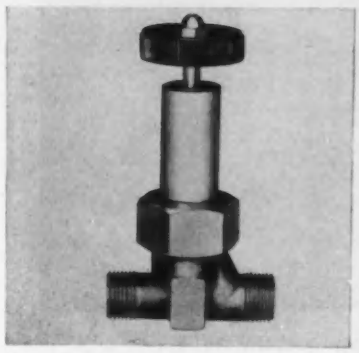
*Specialty Component Motor Dept., General Electric Co., Schenectady 5, N. Y.*

## Square and Rectangular Oil-Filled Capacitors

For use under conditions of moisture and humidity, a complete series of square and rectangular type capacitors has been made available in a wide variety of case sizes. They range in working voltage from 600 to 6000 v,

dc and operate efficiently at temperatures from —40 to 70 C. Units filled with a new special dielectric will operate from —70 to 90 C. Wax impregnation is also available. Capacitors are hermetically sealed in lead-coated steel cases. They can be supplied with porcelain standoff terminals or riveted solder lug terminals for voltages below 2500 v, dc. Standard capacity tolerance is plus or minus 10 percent. Test voltage is twice that rated from terminal to terminal and twice that rated plus 1000 v from each terminal to case.

*Industrial Condenser Corp., Dept. PEN, 3243 N. California Ave., Chicago 18, Ill.*



## Small Bellows Valves

A series of small bellows valves has been specifically designed for highly corrosive applications, high vacuum work and mass spectrometry.

Tests show this assembly is capable of withstanding more than 100,000 cycles, at low pressure, in non-corrosive service. The valve body is constructed of 316 stainless steel, with Teflon seat and gasket. Both seat and bellows assembly are replaceable.

These valves provide a low leakage rate across the seat and into the valve. Another advantage is a back-seating feature, especially useful in corrosive fluid application, in event of a bellows rupture.

Pipe sizes available are $\frac{1}{8}$ to $\frac{1}{2}$ in., with $\frac{1}{4}$ and $\frac{1}{2}$ in. tube ends.

*Hoke, Inc., 197 S. Dean St., Englewood, N. J.*

## Miniature Dc Solenoid

These small solenoids may be used for the operation of keyboards, light springs, control board signal flags, door latches and similar applications. They measure $\frac{3}{4}$-in. dia approximately


**MUELLER BRASS CO. forgings* contribute to the efficiency of this modern waste disposal unit**

***MUELLER BRASS CO. facilities include: designing, die-making, forging, tooling, machining, polishing, plating and assembly**

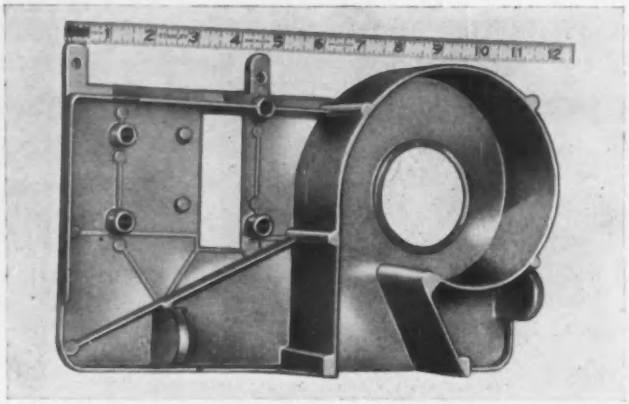
Three Mueller Brass Co. forgings play an important part in the fine operating performance of this modern waste disposal unit made by the Eureka-Williams Co., Division of the Henney Motor Co., Inc. This unit does a speedy and thoroughly effective job of pulverizing garbage and has made life easier for American housewives. The impeller disposer that chops up the waste food in the disposal unit, the disposer cover and the sink mounting flange are all forged by the Mueller Brass Co. This is another outstanding instance where Mueller Brass Co. forgings have improved product performance and cut costs. High quality forgings can be produced from standard and special brass, bronze and aluminum alloys. And in addition, the Mueller Brass Co. offers complete service ranging from product design to finished part . . . Write today for complete information and new 32 page forgings handbook.

1. Sink mounting flange, forged, machined, nickel and chrome plated by Mueller Brass Co.
2. Machined and finished disposer cover forging.
3. Cutting side of impeller disposer forged from 600 series bearing bronze.
4. Reverse side of impeller disposer.

**MUELLER BRASS CO.**

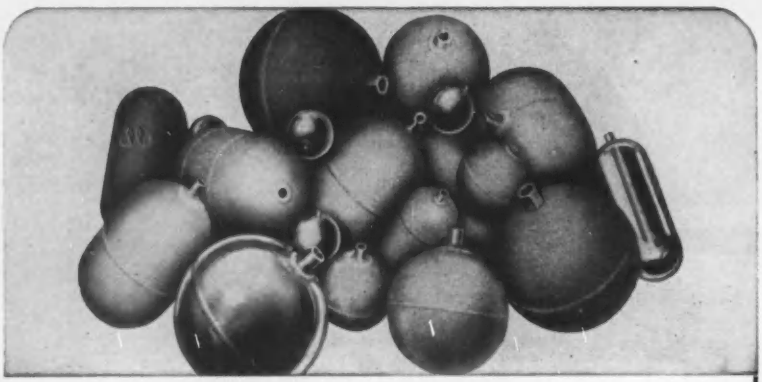
**PORT HURON 17, MICHIGAN**

*An asset to your product...*



*.... our aluminum castings*

FEDERAL DIE CASTING CO.
2228 N. ELSTON AVE. CHICAGO, 14, ILL.
PHONE ARmitage 6-4803



**Send for Nicholson**

**FLOAT BULLETIN 753**

*Complete Data on Welded Floats; Diagrams, Tables, Formulae for Calculating Buoyancies*

The booklet is a standard reference for specifiers of welded floats. Nicholson furnishes any type for external or internal pressures; in stainless steel, Monel, chromium, cadmium or copper-plated steel. Sizes, 2" to 14" diam., press. to 4250 lbs.; standard or special connections. Quick delivery on many sizes and shapes. Nicholson floats are standard with hundreds of manufacturers.

W. H. NICHOLSON & CO.
TRAPS · VALVES · FLOATS

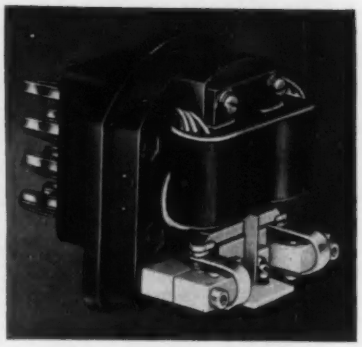


1½-in. length. Either may be wound for a wide range of d-c voltages. Their weights are 0.122 and 0.141 lb respectively.

The nylon bobbin is used as a bearing surface, effecting self-lubrication as well as insulation. Armatures are made of high grade soft iron. Leads are on the side for convenience and mounting.

An example of pull characteristics is the 24 v, 13 amp type which is operated on intermittent duty, 5 sec max on time with a 20 C ambient to pull 25 oz at ¾ in. stroke.

*Cannon Electric Co., 418 W. Ave. 33, Los Angeles 31, Calif.*



## High-Speed, Sensitive Polar Relay

A new polar relay features exceptional sensitivity for high-speed pulse repeating and dependable performance where low current is transmitted over long lines.

No critical adjustments are necessary. Spacing of contacts takes only a simple set-screw adjustment and the unit has performed billions of operations without readjustment.

The relay meets the speed and sensitivity requirements for tele-typewriters and is recommended for line current direction indication or as a differential relay in the "Wheatstone bridge" type of control.

Compact in size, it measures only $2\frac{7}{16}$ x $2\frac{1}{4}$ x $3\frac{5}{16}$ in. The snap-on cover is easily removed for visual inspection.

*Automatic Electric Sales Corp., 1033 West Van Buren, Chicago 7, Ill.*

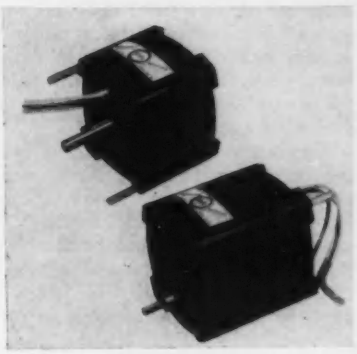
## More Air With Same Size Blower

New blower wheels for heating, cooling and ventilating equipment are being produced in $5\frac{1}{8}$ and $5\frac{3}{4}$ in. dia. These are two additional sizes, which

have been found necessary because of the need to obtain additional air within the physical size limitations of existing equipment. The new $5\frac{1}{8}$ in. model is available in widths of $1\frac{1}{8}$, $2\frac{1}{16}$, $2\frac{15}{32}$, $2\frac{7}{8}$, $3\frac{1}{8}$ and $3\frac{1}{2}$ in. The $5\frac{3}{8}$ in. is being manufactured in widths of $1\frac{5}{32}$, $2\frac{1}{16}$, $2\frac{1}{2}$, $2\frac{29}{32}$, $3\frac{1}{8}$, $3\frac{1}{2}$, $3\frac{25}{32}$ and $4\frac{1}{4}$ in.

In addition to the new blower wheels, this manufacturer produces units in diameters of $4\frac{1}{4}$, $4\frac{3}{4}$, $5\frac{1}{4}$, $6\frac{5}{16}$, $7\frac{5}{16}$, $7\frac{29}{32}$, $8\frac{1}{4}$, $9\frac{13}{32}$ and 11 in.

*Torrington Mfg. Co., Torrington, Conn.*



## Electric Motors With 1/750 To 1/2000 Hp Rating

A new type of electric motor is being offered in either two or four-pole synchronous or induction types with ratings of 1/2,000, 1/1,500, 1/1,000, or 1/750 hp, with power dissipated within safe temperature rise. The motors are totally enclosed, using precision-machined die-cast alloys for end bells and gear train cases.

Any of the series can be supplied with or without an internal gear train. Standard models are designed for operation on 115 v, 60 cycle current. They may also be obtained with special voltages and frequencies.

Similar motors have proved successful in watch rate recorders and other precision equipment for many years. They are now being made available to the electrical industry.

*The George W. Borg Corp., 120 So. Main St., Janesville, Wis.*

## Centrifugal Pump With 30 gpm Capacity

A new small centrifugal pump made of stainless steel has been developed for handling a wide variety of corrosive chemicals or for non-contaminating service in food, biological and similar applications.

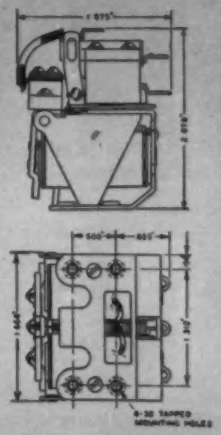
Maximum capacity is 30 gpm. It


*Where* **SHOCK** *and* **VIBRATION** *are a Problem . . .*

**ENGINEERS CHOOSE the rugged Phil-trol 27 RELAY**

**For AVIATION and ELECTRONIC INDUSTRIES**

TYPE 27QA—3 POLE

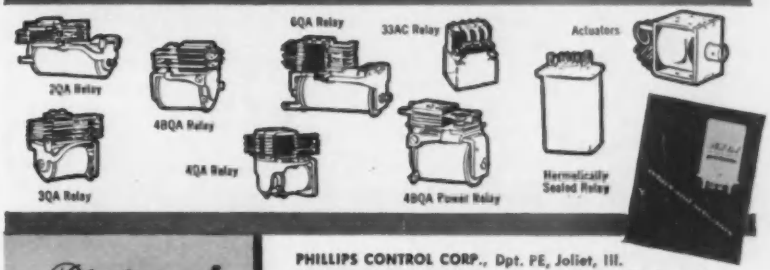


Phil-trol Type 27 Relays are available in 1, 2, 3, 4 or 5 pole, single or double throw. Operating voltage up to 230 D.C., resistance up to 13,400 ohms, minimum operating current is .001 amps. Available enclosed in dust cover or hermetically sealed.

■ Proved performance of Phil-trol 27 Relays in many vitally important applications has built great demand for this sturdy, sensitive and highly efficient relay. For instance, they are used for: propeller pitch control . . . cabin pressure and temperature control . . . guided missiles . . . computers . . . communication equipment . . . and many other electronic devices.

Phil-trol 27 Relays have unusual features like two-coil construction, which allows greater operating force for a given power input, and also completely eliminates magnetizing force losses at the armature hinge. The rigid frame and balanced armature design provides stability under conditions of high acceleration, severe vibration or shock.

**For complete details on all of the many Phil-trol Relays available, write for the new Catalog shown below.**




*Phil-trol*
IS THE REGISTERED TRADEMARK OF
PHILLIPS CONTROL CORP.
JOLIET, ILLINOIS
A THOR CORPORATION SUBSIDIARY
OFFICES IN ALL PRINCIPAL CITIES

PHILLIPS CONTROL CORP., Dpt. PE, Joliet, Ill.
Please send me a free copy of the new Phil-trol Relay and Actuator Catalog. Also, please arrange to have a Phil-trol Sales Engineer call on me.

Name_____
Company_____
Street_____
City_____ Zone____ State_____

wider and wider use

PEARLITIC MALLEABLE CASTINGS

as engineers become aware of its many advantages

**DESIGN ADAPTABILITY:** Because of its good fluidity, it can be cast in thin sections and in complicated shapes.

**HIGHER STRENGTH:** Ultimate strengths range between 60,000 and 90,000 psi; yield strength between 40,000 and 70,000 psi.

**EASILY MACHINED:** Machinability index (B1112 Steel = 100) ranges between 80 and 90.

**WEAR RESISTANCE:** Withstands excessive wear under heavy loads at high speeds.

**LOCALIZED HARDENING:** Sections of the casting can be flame hardened or induction hardened before or after machining.

**BEARING PROPERTIES:** Good non-seizing properties in metal-to-metal contact.

**FINE FINISH:** Can be given a very smooth finish where desired.

You will find many applications for Pearlitic Malleable castings — particularly as a replacement for forgings, stampings and weldments — where reduced weight, less machining time, fewer assembly operations and better appearance are important production and sales considerations. A-2254

NATIONAL MALLEABLE AND STEEL CASTINGS COMPANY

Cleveland 6, Ohio

The Nation's largest independent producer of malleable and pearlitic malleable

will pump against a head up to 24 lb and has a maximum suction lift of 20 in. vacuum.

Rear suction and discharge permits complete access without disconnecting pump from line. Fluid being pumped is fully visible through "Pyrex" front cover plate. Access to internal parts is accomplished by the removal of two wing nuts.

Continuous suction on stuffing box reduces the possibility of absolute minimum of material being pumped entering the mechanical seal. Impeller is screwed directly onto motor shaft, providing perfect alignment and sustained concentricity of the seal. This pump is reported to be unusually quiet in operation.

*Eco Engineering Co.,*
12 *New York Ave., Newark* 1, *N. J.*

## Self-Cleaning, Low-Resistance Switch

A self-cleaning switch designed for use in test equipment is a twelve-position, continuous rotation, detent action type with phosphor-bronze wiper contacts. Internal resistance of the unit is asserted to be extremely low and should permit its use in the most precise equipment.

*Industrial Instruments, Inc.,*
89 *Commerce Road, Cedar Grove, N. J.*

## Rotary Selector Switches

New subminiature rotary selector switches and a new two-circuit double-break basic switch are now available. The rotary switches permit switching as many as eight different circuits with one assembly. They are available with from two to eight switching units and from two to eight detent positions, with a 45-deg angle between detents. Virtually any switching sequence is possible.

The rotary selector switches are panel-sealed. Their small size makes them particularly well suited for use

on electronic equipment control boards where space is at a premium. The eight-switch assembly requires only a $1\frac{1}{64}$-in. dia. mounting surface and its over-all length is less than 4 in.

Use of ultra small, single-pole, double-throw switching units makes possible a compact switch assembly with an almost infinite number of wiring combinations. In the eight-switch assembly, four switches can be wired normally open and seven normally closed.

The switches are available with drilled, solder type terminals, or wrap-around, turret terminals. They are rated for an inductive load of 3 amp at 30 v d-c and 10 amp at 125 or 250 v a-c.

The new double-break switches are designed to control two isolated circuits. By use of a snap-action spring, almost simultaneous make and break of both contacts is accomplished, in both the normally closed and normally open circuits.

Because of their small size ($\frac{1}{2}$ x $\frac{1}{2}$ x $1\frac{1}{4}$ in.), double-break switches are especially useful on reversing circuit applications where space is at a premium. Two screw terminals (one normally open and one normally closed) extend from either end of the phenolic case. The terminals are plated for soldering for applications in which the switch is used without the screws. Two 0.101-in. dia. holes on a 0.520-in. center are provided for mounting the switch in a fixed position.

Two circuit, double-break switches will switch 10 amp at 125 or 250 v a-c, and 10 amp at 30 v d-c, inductive.

*Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.*

## Miniaturized Servo Amplifier Requires No D-C Supply

A new miniaturized servo amplifier which eliminates the need for an external d-c source, is of the plug-in, hermetically-sealed type. It is designed to control its companion 400-cycle, two-phase servo motor requiring 2 w electrical input to the control phase.

The circuit design incorporated in the "SA118H" is said to offer high efficiency with unusually low input power. Gain is about 7000. The amplifier operates directly from the output of a tapped transformer. Weight is only 15 oz and the unit is only slightly larger than a pack of cigarettes.

The power supply designed for operating one of the new amplifiers and

Color Television
applications
unlimited!
RCA NEW COLOR TELEVISION CAMERA
gives Camloc fasteners another
chance to prove their versatility
Camloc quarter-turn fasteners belong wherever panels or doors are designed for speedy access. On this intricate color camera, as well as the many other applications where Camloc fasteners are employed, they mean quick engagement, firm grip and quick release.
Write for our illustrated brochure containing descriptive information on the basic Camloc fastener line.
CAMLOC
FASTENER CORPORATION
62 Spring Valley Road, Paramus, N. J.
WEST COAST OFFICE: 5410 WILSHIRE BLVD., LOS ANGELES, CAL.

made by the same company is of the same miniaturized style. To further reduce the installation area required, the bases of these two components nest together. Amplifier requires no bulky parts such as output or driver transformers, chokes or large filter capacitors.

*Servomechanisms, Inc., 500 Franklin Ave., Garden City, Long Island, N. Y.*

## High Temperature Germanium Diodes

These diodes were especially developed for equipment operating at a high ambient temperature and consequently they are asserted to have superior forward and reverse characteristics. They may be identified by the special red dot marking on the glass housing. Each unit is sealed so that exposure to 95 percent relative humidity for 500 hr at temperatures from 9 to 85 C will not appreciably change back resistance or cause hysteresis.

The "Red Dot Type G44" has a minimum of 100,000 ohms resistance at —30 v and 100 C. These diodes are designed for either clip-in or solder-in application, measuring $\frac{5}{32}$ in. in diameter and $\frac{3}{8}$ in. in length with $\frac{3}{16}$ in. clip pins. All are supplied with No. 24 tinned copper, pigtailed leads.

*International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.*

## Close-Coupled Centrifugal Pump

A new close-coupled centrifugal pump is expected to see extensive service in air-conditioning cooling towers, in food and beverage plants and in industrial plants.

These pumps are of 1½ in. discharge, in 2, 3 and 5 hp sizes. They have capacities up to 150 gpm and heads up to 140 ft.

*Carver Pump Co., Muscative, Iowa*

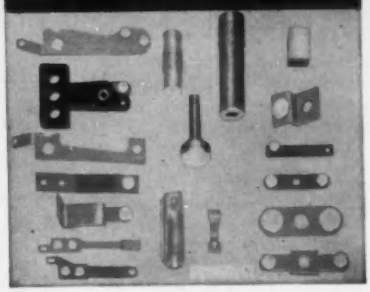
## Dry Film Coatings With Epoxy Base

Two products offer the advantages of the new epoxy resins as a base for dry, lubricating coatings. Films properly formed with these dispersions one containing colloidal graphite, the other molybdenum disulfide—are reported show excellent adhesion and wear-resistance. They are unaffected by oils

The FRYGUIDE on Sunbeam's new appliance has to stay clear, legible and *in place* under extremes of heat, moisture, and abrasion of daily cooking and washing. Metal-Cal meets requirements for Sunbeam, as it does for hundreds of America's finest products.

Metal-Cal is .003-inch aluminum foil, applied with a pressure-sensitive adhesive that bonds to any smooth cohesive surface. The design is created in brilliant dyes, absorbed and sealed into an anodized surface. Metal-Cal gives you bright, *lasting metal* for your nameplates, labels, or other marking needs. No costly drilling, screws, rivets when you use Metal-Cals.

Give Your Product
A HEAD START
With Gibson
ELECTRICAL
CONTACT
ASSEMBLIES



Making complete electrical contact assemblies is a Gibson specialty that often means customers' money saved. We have the correct materials and equipment to do the job. Although we can furnish Gibson contacts of any type for assembly in your own plant, many of our customers find it economical to have us do the entire assembly job.

Engineering skill and production experience come into play. This is important because the attachment of contacts to supports is vital to total performance of your product.

Special Gibson copper alloys with high conductivity and strength are available for making contact supports—to which contacts may be welded, brazed or riveted.

Gibson contact assemblies can be made with the most economical and satifactory combination of contact form and assembly method to suit your product. Gibson-designed, Gibson-manufactured contacts and assemblies will give outstanding performance in your electrical circuit breakers, contactors, instruments, relays, rheostats, signaling equipment, switches, tap changers, thermostats, domestic appliances, and other electrical and electronic products.

For engineering data on Gibson contacts and assemblies, write for free Cat. C-520. It's yours at no obligation.

*Contacts Engineered to Your Requirements*

Gibsiloy
ELECTRICAL CONTACTS
Manufactured by
GIBSON ELECTRIC COMPANY
8358 Frankstown Ave., Pittsburgh 21, Pa.

Tracing design on glass cloth from metal loft at A. O. Smith Corp., Rochester Works.

# Valuable originals protected against wear and tear

At the A. O. Smith Corp.'s Rochester (N.Y.) Works, large drawings are made exactly to scale on glass cloth. Since these drawings often cost several hundred dollars each, A. O. Smith naturally does not wish to expose them to possible damage during print-making and to the wear and tear of excessive handling. Instead, they use intermediates made on Kodagraph Autopositive Paper.

Costing but a few cents a square foot, Autopositive produces positive photographic prints directly from the original drawings — without a negative step or darkroom handling. It can be exposed in standard print-making equipment and processed in standard photographic solutions. (A. O. Smith uses a vacuum-frame printer, which accommodates drawings up to 8 x 4 feet in size.)

**No worries with Autopositive intermediates** — they turn out sharp, legible shop prints time after time. Their dense photographic black lines do not smudge or smear. And they can be run at uniform, practical speeds in the company's direct-process machine.

In addition, A. O. Smith keeps an "Autopositive File" showing the history of changes in all their drawings. Before each revision, an Autopositive intermediate is made. Later on, direct-process prints showing the complete story of each design can be made from the intermediates as needed.


## Kodagraph Autopositive Paper

**"THE BIG NEW PLUS" in engineering drawing reproduction**

MAIL COUPON FOR FREE BOOKLET

15

Shows all the ways you can save with Kodagraph Autopositive Paper.

**EASTMAN KODAK COMPANY**
**Industrial Photographic Division, Rochester 4, N. Y.**

Gentlemen: Please send me a copy of "Modern Drawing and Document Reproduction."

Name_____ Position_____

Company_____ Street_____

City_____ Zone____ State_____

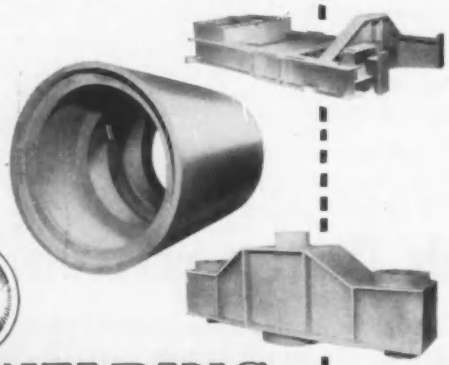
Kodak

# NAVY CRANE RIDES HIGH on ACME Weldments

**220 feet** below the hook is quite a reach. When the Navy needed a portal crane that big to swing heavy sections on to vessels under construction, the Derrick & Hoist Corporation of Long Island City designed and built a diesel-electric giant with the right reach and a capacity of 50 long tons. *Carrying this big load are all-welded components fabricated by Acme Welding.*

**ACME weldments** were chosen in place of castings to assure *greater strength, rigidity,* and complete absence of flaws . . . to eliminate pattern cost . . . to provide greater design flexibility. If these advantages of welded fabrication are important to your product —especially when combined with exact adherence to your specifications—why not investigate Acme weldments *today.*

Send us your blueprints for a prompt quotation and ask for our informative booklet, "The FACTS about WELDMENTS and CASTINGS." Ask for Bulletin B-2



Acme WELDING

DIVISION of THE UNITED TOOL & DIE CO.

1064 New Britain Ave. • West Hartford 10, Conn.

National Representative TRANSMISSION EQUIPMENT CO., Inc.
441 LEXINGTON AVE., NEW YORK 17, N. Y.




and solvents, and can be used wherever temperatures do not go above 500 F. All types of surfaces, whether or not pretreated by chemical or mechanical means, can be coated. When applied in accordance with manufacturer's recommendations, corrosion-resistance, as well as lubrication, can be obtained from these films.

Typical uses for these products will include dry lubricating films for high-temperature screw threads, precision gears, bearings, shafts. In certain applications where electrical conductivity is desired, along with good heat stability, the dispersion of graphite in epoxy resin should provide the necessary properties.

*Acheson Colloids Co., Port Huron, Mich.*

## Heavy Duty Motor For Instruments

A new speed reducer motor, said to be designed for continuous duty industrial applications requiring sturdy construction and exceptional reliability, has been announced. All gearing is of the helical type, accurately hobbed to AGMA Commercial Class 3 tolerances. The helical gearing provides increased load carrying capacity, reduces noise through smoother tooth action and produces more uniform pitch line velocity, as compared to spur gears.

Speeds of the K-2RM motor range from 280 to 0.7 rpm with torque ratings from 2.7 to 120 in.-oz. The unit has high starting torque of not less than 150 percent of full-load torque at room temperature. There are no internal switches, brushes or permanent magnets. Windings are distributed for highest efficiency—both synchronous and non-synchronous are available. Motor has three leads and is reversible. Dimensions are $2\frac{3}{8}$ by $2\frac{3}{8}$ by length of $2\frac{37}{64}$, $2\frac{45}{64}$, $3\frac{23}{64}$ in.

*Bodine Electric Co., 2254 W. Ohio St., Chicago 12, Ill.*

## Coolant Pump Handles 17 Gpm

In spite of its compact design, this new coolant pump is reported to deliver 17 gpm under a 12 ft head with water. It is designed to handle liquids, even containing abrasives, through a wide range of viscosity, with ample reserve horsepower to prevent overloading the motor.

No pipe is necessary below the unit's self-mounting flange. Discharge pipe is above the mounting flange, resulting

# a New DOOR ACTUATOR for Transport Aircraft

EEMCO technical bulletin

TYPE D-607 WITH COVER REMOVED

EEMCO's new linear actuator, Model D-607 is a compact combination actuator and power package weighing only 4½ pounds. Having a stroke of 6¼ inches at .3 inches per second under a normal operating load of 450 pounds, it is another example of the ingenuity and precision of EEMCO's design and production team. Overall size of the activating section of Model D-607 is only 2¼" x 4½" x 8⅝". Other specifications are shown below. This same design can be altered for adaptation to other uses with a minimum of production time thus assuring early delivery.

## SPECIFICATIONS ★ TYPE D-607

**Weight:** 4.5 pounds **Stroke:** 6.25 inches
**Operating load:** 450 lbs.
**Ultimate static load:** 7150 lbs. tension
**Speed of stroke** under 450 lb. load: .3 inches per sec.
**Size of power section:** 2¼" x 4½" x 8⅝".

**Other features:** Magnetic clutch and brake for quick stopping; adjustable travel limit switches; non-jamming end stops; radio noise filter; explosion proof.

NOTE COMPACTNESS OF COMPLETE UNIT

**Electrical Engineering and Manufacturing Corp.**

4612 West Jefferson Boulevard
Los Angeles 16, California

Designers and producers of motors, linear and rotary actuators

9-527

Whatever type of machine screw you need, Blake & Johnson has it... or can make it for you. Slotted or Phillips heads – in brass and steel, plain or plated. Special designs, sizes, and finishes to order. Blake & Johnson is the dependable source for Twin-Fast® wood screws, stove bolts, tapping screws, special headed products, machine screw nuts, rivets, chaplets, wire forms, automatic screw machine products... in steel, brass, or other alloy metals.
Write for new catalog ▶
MACHINE SCREW NUTS
TAPPING SCREW
TWIN-FAST SCREW
SPECIAL WIRE FORM
BLAKE & JOHNSON
SINCE 1849
WATERVILLE 49, CONNECTICUT
fastenings



in a saving of installation time, pipes and fittings. The pump is mounted in the machine tool sump or in the top mounting in tanks or containers. The new unit comes in two standard immersion lengths—6½ and 8½ in.

There is no metal-to-metal contact between moving parts and the shaft and moving parts are enclosed and protected by the pump casing.

*Graymills Corp.*, 3705 *N. Lincoln Ave., Chicago* 13, *Ill.*

## Selenium Rectifiers for Load Currents Under 50 Milliamperes

A series of miniature selenium rectifiers for electronic equipment such as television boosters and UHF converters requiring a load current of 50 milliamperes or less is now in quantity production. They are equally useful for experimental devices and electronic equipment having relatively low current drain.

The new series consists of a number of selenium cells assembled within a cylindrical aluminum housing, ranging in size from 0.375-in. dia and 0.625-in. length to 0.750-in. dia and 0.625-in. length. CR series rectifiers have a d-c output current of 10 to 50 milliampere. Type CR28 of this series is rated for a maximum of 130 v input and will deliver approximately 170 volts dc at 20 milliampere with a capacitive filter.

*International Rectifier Corp., El Segundo, Calif.*

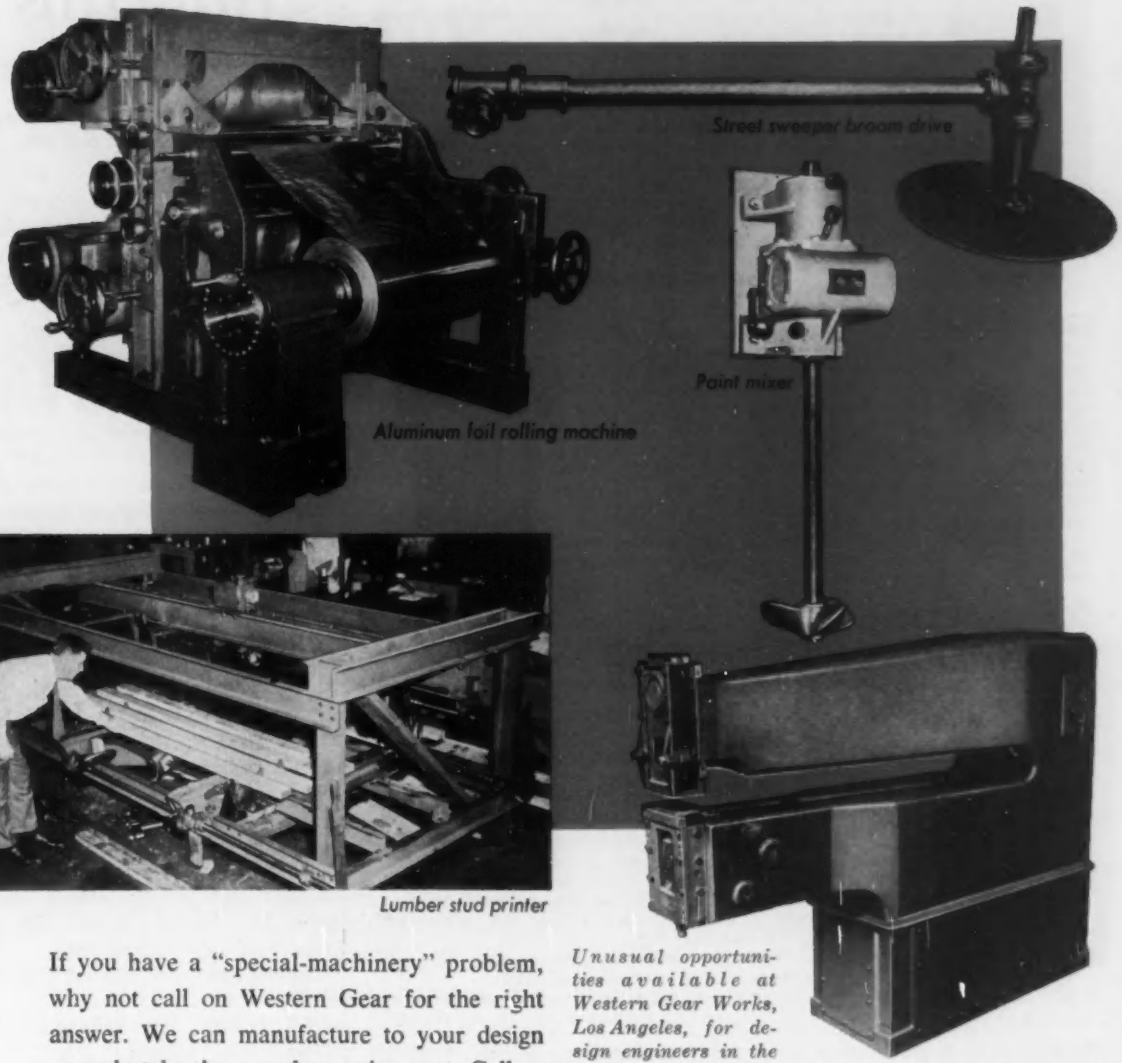
## Stock Cylinders

This manufacturer, which formerly supplied mainly custom air and hydraulic cylinders, is now making a line of "stock" cylinders, with solid steel heads, caps and mountings, hard chrome-plated piston rods, dirt wiper seals, lead-proof piston and rod seals that never require adjustment.

Both cushioned and non-cushioned styles are included. Non-cushioned models are: 2, 2½, 4 and 6-in. bore air cylinders and 1½, 2½ and 4-in. bore hydraulic cylinders. All of these are available in 2, 4, 6, 8 and 11-in. strokes. Cushioned both ends: 2 and 3¼-in. bore hydraulic cylinders and 2, 3¼, 5 and 8-in. bore air cylinders. All available with 3, 5, 7, 9 and 12-in. strokes. Miller Motor Co., 2040 N. Hawthorne Ave., Melrose Park, Ill.

# *Special Machinery* did you say?

## that's a WESTERN GEAR *Specialty!*






*Lumber stud printer*

*Plywood patching machine*

If you have a "special-machinery" problem, why not call on Western Gear for the right answer. We can manufacture to your design or undertake the complete assignment. Call us now—whether your idea is still in "the talking stage" or ready to proceed. We'll save you time and money.

*Illustrations show a variety of machines manufactured by Western Gear. For further information, please write Western Gear Works, Executive Offices, P.O. Box 182, Lynwood, California.*

*Unusual opportunities available at Western Gear Works, Los Angeles, for design engineers in the following fields: gas turbine, marine propulsion equipment, aircraft equipment, fine pitch gearing and printing industry equipment. Write personnel manager P. O. Box 183, Lynwood, Calif.*

**GEARMAKERS, ENGINEERS AND MANUFACTURERS "SINCE 1888"**

**WESTERN GEAR WORKS**

**PACIFIC-WESTERN PRODUCTS** | POWER TRANSMISSION GEARS • MACHINERY •

PACIFIC GEAR & TOOL WORKS · SOUTH WESTERN GEAR WORKS

5410

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

# FILTER REQUIREMENTS in the AUTOMATION PROGRAM

## For Hydraulic and Other Low Pressure Liquid Circulating Systems

SUMP TYPE
(Cutaway)

Before the change over to Automation becomes a reality, every consideration will be given to the operating efficiency of all equipment that will enter into this program.
Every piece of equipment will be called upon for its maximum productive effort for the longest period of time. Careful consideration will also be given to the selection of accessories and components of equipment to achieve these results to the greatest possible degree. The rapid growth and ever increasing applications of hydraulic principles to production equipment strongly indicates that the greatest actuating force in the Automation program will be hydraulic. Since the heart of any hydraulic system is the pump, the selection of a filter for its protection will demand top consideration.
To filter out the damaging particles that cause approximately 75% of all hydraulic troubles, calls for the installation of a filter that meets certain established standards, such as

**BALANCE**—The balance between active filtering area and sufficient storage capacity for filtered out particles is a "must". This balance provides an even flow of liquid at a constant, steady rate of speed produced by the pump and brings about the desired effect of a gentle evenly distributed accumulation of filtered out particles against the entire filtering surface with a minimum restriction of flow. Thus, longer periods of productive operation are attained at absolute minimum of filter maintenance "down time". If this important balance is lacking due to efforts to cram too much filtering mesh for the sake of total, rather than active area, filter soon becomes clogged causing pressure build-up, turbulent flow and requires frequent maintenance or replacement.

LINE TYPE
(Cutaway)

**CONSTRUCTION**—Designed so that when filter requires service or cleaning, it can be done by any workman as easily and quickly as possible without the necessity of carrying spare parts in stock or the purchase of an entire unit for replacement.

## Over 475 Original Equipment Manufacturers Install MARVEL SYNCLINAL FILTERS as Standard Equipment

Over 475 Manufacturers of hydraulically actuated and other machines utilizing low pressure liquid circulating systems, install MARVEL Synclinal Filters as standard equipment, because—MARVELS are designed to give this all-important balance between minimum active filtering area and sufficient storage space for filtered out particles—

**MARVELS** are constructed so they can easily be disassembled, cleaned and reassembled by any workman in a matter of minutes—

**MARVELS** are available for convenient installation either in sump or on line. Line type operates efficiently in any position and may be serviced without disturbing pipe connections—

**MARVELS**, both sump and line types, are available in capacities from 5 to 100 G.P.M. and choice of mesh sizes ranging from coarse 30 to fine 200.

**MARVELS** deliver a filter to meet your specific sizes and requirements AND DELIVER IMMEDIATELY! If desired, shipments are made on same day order received.

## Depend on MARVEL Synclinal Filters For The Protection of All Hydraulic and Low Pressure Systems

**MARVEL ENGINEERING CO.**

625 W. Jackson Blvd.
Chicago 6, Ill.
Phone: Franklin 2-4431

Marvel Engineering Company PRE-8
625 W. Jackson Blvd., Chicago 6, Ill.

Without obligation, please send me complete data on Marvel Synclinal Filter as follows:

Catalog No. 300 for Water Filters
Catalog No. 106 for Oil Filters

Name .....
Company .....
Address .....
City ..... State.....


# Catalogs and Bulletins

**Request additional information using postcards following page 256**

(1) TAPE-WOUND CORES—Thomas and Skinner Steel Products Co., Inc., Indianapolis, Ind. Bulletin WC-353 describes tape-wound cores for saturable reactors, power transformers and other electronic and electrical applications. Tape-wound cores in both rectangular "C" and round toroidal types are included. Specifications and value graphs are provided, covering cores in 12 mil oriented silicon-iron, for 60 cycle applications and in 4 mil for 400 cycle and higher applications. The value graphs give evidence of high flux densities, with correspondingly low losses. Also shown by graph is this material's orthographic characteristic, providing an extremely rectangular hysteresis loop.

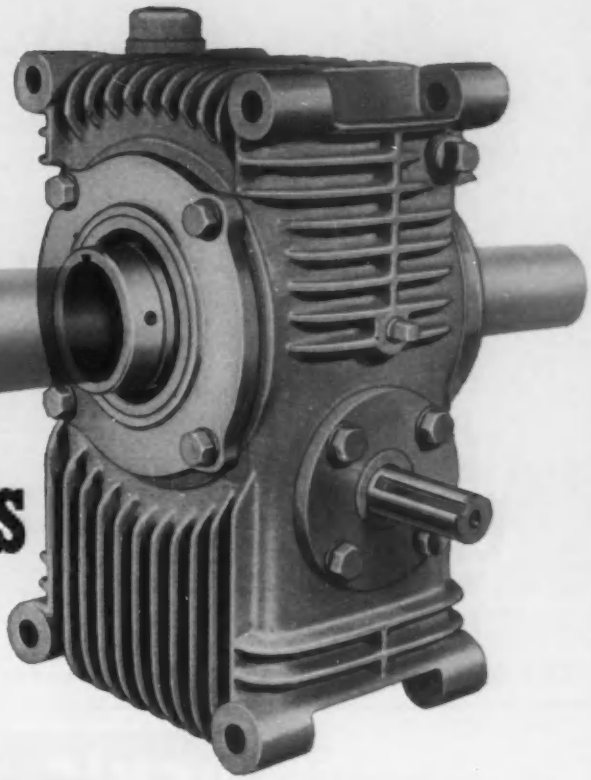
(2) WELDED CHAIN—McKay Co., 329 McKay Building, Pittsburgh 22, Pa. Bulletin B, 16 pp. Gives working load limits, material diameter, link sizes, finishes, packaging and other data required to specify welded chains for all types of applications. Both fire welded and electric welded chains made from low carbon steel, high carbon steel and alloy steel in the standard types and sizes are included.

(3) PULSE TRANSFORMERS—Utah Radio Products Co., Inc., 1123 E. Franklin St., Huntington, Ind. Catalog, 4 pp., lists the electrical and physical characteristics of blocking oscillator or regenerative driver, pulse transformers. Pulse voltage, pulse duration, maximum duty ratio, load impedance, RMS test voltage, induced voltage, and d-c resistance are given.

(4) SPRING PINS—Standard Pressed Steel Co., Jenkintown, Pa. Folder, 4 pp. Typical applications pictured are as axles in caster assemblies, as keys

*Announcing* **a versatile new line of reducers**

# CONE-DRIVE SHAFT MOUNTED SPEED REDUCERS



Now, designers can take advantage of the unique double-enveloping worm gear design of Cone-Drive gears in shaft mounted speed reducers. The right angle between input and output shafts offers many application and space-saving advantages over conventional gearing. The reducers are mounted directly on the driven shaft and require only a simple bracket or torque arm to prevent rotation of the reducer.

The new reducers can be readily motorized, if desired. A bell housing is available to accommodate standard NEMA C-type flanged motors. Expensive couplings are not required since a tang-type drive sleeve and suitably machined worm are provided with the bell housing to match the motor shaft being used.

Standard reduction ratios range from 5:1 to 60:1. When the motor is connected to the input shaft by means of vee-belts or pulleys, additional speed reduction can be easily obtained. Bore sizes are available to accommodate shafts from 1" to 2½" in steps of 1/16". All sizes are available from stock.

*Complete engineering details are available in Bulletin CD-323. It's free for the asking.*

MORE HP PER POUND ★ MORE HP PER CUBIC INCH ★ MORE HP PER DOLLAR

CONE-DRIVE GEARS

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

CONE-DRIVE GEARS
*Division, Michigan Tool Company*
7171 E. McNichols Road • Detroit 12, Michigan

Everyone knows this
is a plus sign...

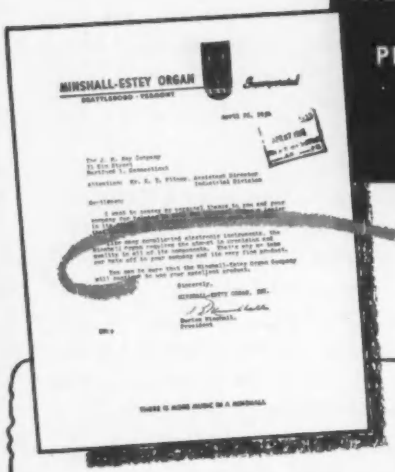
And smart gear users know
this CINTI is the sign of
the best in custom made gears.

CINTI "Gears...Good Gears Only"

THE CINCINNATI GEAR CO. • CINCINNATI 27, OHIO



NEY'S SMALL PARTS
PLAY A BIG PART IN
PRECISION
INSTRUMENTS




*"Like many complicated electronic instruments, the Minshall Organ requires the utmost in precision and quality in all of its components. That's why we take our hats off to your company and its very fine product."*

With ideal physical and electrical properties, resistance to tarnish and most corrosive atmospheres, Ney Precious Metals, fabricated into slip rings, brushes, wipers, and contacts, have again demonstrated their superiority for use in precision electrical and electronic apparatus. Improve the accuracy and prolong the life of your instrument by using Ney Precious Metal Alloys. Write today to...Engineering Department.

THE J. M. NEY COMPANY

*Specialists in Precious Metal Metallurgy Since 1812*

109 ELM STREET, HARTFORD 1, CONNECTICUT 13NY54B




in gear assemblies, as lock pins in door handles, as hinge pins, as fasteners holding laminated sections together, as stop pins and as cotter pins. Dimensions of standard and light-duty spring pins, their shear strength and recommended minimum and maximum hole sizes are also given.

(5) CURRENT-LIMIT FUSES—General Electric Co., Bridgeport 2, Conn. Booklet, 8 pp, tells where and why these fuses should be used and provides construction details, ratings, dimensions. Curves showing current-limiting characteristics and melting time-current characteristics for both 250 v and 600 v fuses are included.

(6) RECORD-PLAYBACK CONTROL—General Electric Co., Schenectady 5, N. Y. Bulletin GEA-6092, 6 pp. A system of recording motion on magnetic tape and playing it back for automatic programming of production machines and processes is described.

(7) TRANSFORMERS—Triad Transformer Corp., Venice, Calif. Catalog TR-54, 28 pp, describes 11 new amplifier kits for high fidelity reproduction, a greatly expanded line of television components, plus additional items in hermetically sealed power components, instrument power supply, filament, chokes, power and audio transformer lines. Two new photo-flash transformers are included in the list of new items. A complete line of geophysical transformers are shown in a special section of the new catalog.

(8) ROLLER CHAIN AND SPROCKETS—Browning Mfg. Co., Maysville, Ky. Catalog CD-102-B, 52 pp, contains complete detailed specifications on stock chain and sprockets, engineering data and tables of hundreds of practical stock drive combinations already worked out for convenient selection.

(9) ELECTRIC HEATING UNITS—Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh, Pa. Booklet, 23 pp. First sections cover strip heaters, forced convection air heaters, room and oven heaters. The complete line of Corox heaters follows, including immersion, bolt, finned and special shaped units. Cartridge heaters, glue and melting pots are included also.

THE *New* HILLIARD

# TWIFLEX

AUTOMATIC CENTRIFUGAL CLUTCH COUPLING *with* *Flexible* ACTION . . .

## 11 NEW IMPORTANT FEATURES . . .

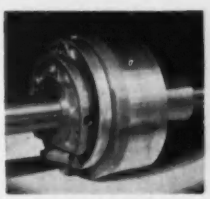
1. Flexible in all directions.
2. Absorbs shock.
3. Limits torsional vibration.
4. Has adjustable idle speed.
5. Can be furnished in automatic free-wheeling type.
6. Smooth starting.
7. No slip under normal load at full speed.
8. Protects driver and driven mechanisms against overload shock.
9. Can be furnished in automatic back-stop type.
10. Prevents torsional resonance.
11. Easily assembled even in blind installations.

If you have problems of misalignment — smooth starting — vibration — overload — or assembly in the manufacture or operation of:

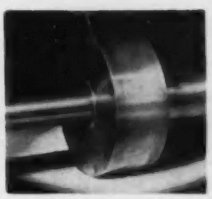
COMPRESSORS
BLOWERS
DIESEL ENGINES
EXCAVATORS
REFRIGERATION EQUIPMENT
• TEXTILE MACHINERY
• WIRE DRAWING MACHINES
• FANS
• GASOLINE ENGINES
• BACK STOP BRAKES
• CONVEYORS
• BALL MILLS
• ELECTRIC MOTORS
• GENERATORS
• HIGH SPEED PULVERIZERS
• LARGE OVERHEAD CRANES
• HAMMER MILLS
• MIXERS
• TUBE MILLS
• PUMPS

• LET OUR ENGINEERS CONSIDER YOUR PROBLEMS. TWIFLEX MAY BE THE ANSWER.

THE HILLIARD LINE OF CLUTCHES •



Single Revolution Clutch
Write for Bul. 230



Over-Running Clutch
Write for Bul. 231

Slip Clutch
Write for Bul. 300

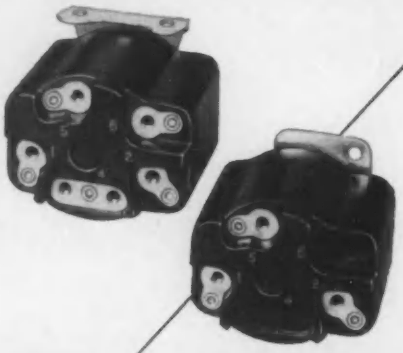
• WRITE TODAY!
for details of TWIFLEX Coupling in Catalog CE-3
•

THE HILLIARD *Corporation* 101 W. FOURTH ST., ELMIRA, N. Y.

• MANUFACTURING CLUTCHES FOR OVER 45 YEARS •

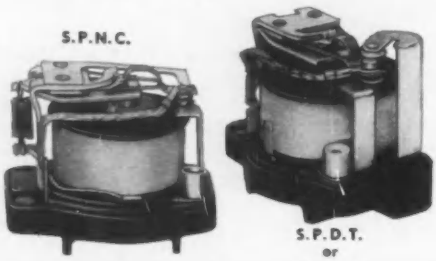
*Mr. Air Conditioning Manufacturer*

**These R-B-M Relays**



**WILL SIMPLIFY YOUR CONTROL PROBLEMS**

● Developed expressly for air conditioning and refrigeration. While designed primarily for capacitor motor starting service, relays are also available with normally open contact rated 1 H.P.— 115 Volts and 1½ H.P.— 230 volts A.C. for sequence starting, motor interlocking or general purpose application.




- **Totally Enclosed**
- **Snap-action Contacts**
- **Non-positional Operation**
- **Accessible Wiring Terminals**
- **Underwriters' Approved. File Nos. SA 1984 and E 12139**

*Write Dept. C-8 for details today*

**R-B-M DIVISION**
**ESSEX WIRE CORPORATION**
Logansport, Indiana

*Controls for Electronic, Refrigeration, Industrial, Appliance, Communication and Automotive Industries*

RBM

**Catalogs and Bulletins.....continued**

Later sections of the booklet are devoted to the selection of the correct heater for a specific application. Here, formulas and graphs are given and sample problems are solved.

(10) GERMANIUM DIODES—International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa., Bulletin N-1, 2 pp. Data on standard types, replacement types, construction, application, dimensions, charts.

(11) BOILER WATER LEVEL CONTROLS—McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill. Catalog, 24 pp. Engineering information is provided, including capacity curves and roughing-in dimensions. Parallel data on the different models is arranged in tabular form for ready comparisons. Both a table of contents and an index are provided to facilitate ready reference and selection.

(12) PRECIOUS METAL RUPTURE DISCS—Baker & Co., Inc., Newark, N. J. Brochure, 8 pp. Several tables and other data concerning the reaction of platinum, silver and gold with the principal corrosive agents and the bursting pressure of rupture discs made from these metals in various working diameters are given. The booklet also explains that the difference in the final cost of the precious metal disc over a base metal disc is negligible, because the precious metal is recoverable with high resale value.

(13) DEPOSITED CARBON RESISTORS—Campbell Industries, Inc., 3806 St. Elmo Ave., Chattanooga 9, Tenn. Bulletin, 6 pp, covers 1 percent resistance tolerance resistors. Three new sizes are described with power ratings from $\frac{1}{8}$ to 2 w, resistance from 10 ohms to 100 megohms. Performance test results, electrical and mechanical characteristics, material and construction details, protective finishes and enclosures available are all included.

(14) ELECTRICAL CONTACT RIVETS — Fansteel Metallurgical Corp., N. Chicago, Ill. Slide chart permits user to select for a given rivet head diameter, maximum and minimum dimensions for head thickness, shank diameter and shank length. When designs are kept within the dimensions and tolerances indicated in

the chart, the contact rivets can be produced rapidly and economically on automatic heading machines.

(15) BOILER WATER COLUMNS AND GAGES—Yarnall-Waring Co., Mermaid Lane, Philadelphia 18, Pa. Catalog WG-1814, 20 pp, describes the round-glass gages for pressures up to 400 psi and the flat-glass gages featuring separated-design, floating assembly and inserts and illuminators for pressures up to 2500 psi.

(16) CABINETS, CASINGS, HOUSINGS—Artisan Metal Works Co., 11400 Madison Ave., Cleveland 2, Ohio. Folder, 4 pp, describes design and fabricating facilities available for production of enclosures for electronic and similar equipment.

(17) TITANIUM TUBING—Superior Tube Co., Norristown, Pa. Bulletin 42, 8 pp, lists chemical analyses, mechanical properties and production limits of commercially pure titanium tubing. Included is general fabrication information and the important characteristics of titanium as selected for a variety of end use applications.

(18) HOLDING FIXTURES—Erickson Tool Co., 23 and Hamilton, Cleveland 14, Ohio. Catalog, 34 pp, describes chucks, holders, mandrels, air cylinders, speed indexers, cutting bars and special holding fixtures. Gives specifications on model dimensions and ranges. Data on recommended uses and possible production savings is also included.

(19) BALL VALVES—S. Morgan Smith Co., York, Pa. Brochure, 8 pp. Manually-operated ball valves from 12 to 48 in. for shut-off service at pressures up to 150 psi, designed for water works and industrial applications, are described and illustrated. Closing conditions, tightness of closure, leverage, operating mechanism and optional end sections are also discussed.

(20) EXPANDED METALS—Penn Metal Co., Inc., Parkersburg, W. Va. Catalog, 28 pp. Describes line of standard and flattened expanded metal, and expanded metal gratings. Included are tables of sizes, weights and dimensions for different meshes, in carbon steel, aluminum, stainless steel, Monel and Inconel. Air flow tables,


DON'T CUT PARTS ...Cut Costs!

2-Piece Cut Assembly 40¢ (Combination spur and helical gear.) Powdermet* Part 8¢

Why pour money into expensive machining operations?

POWDERED METAL PARTS can do the job for *much less!*

Machined Part 75¢ Powdermet* Part 10¢

Machined Part 60¢ Powdermet* Part 12¢

Machined Part $2.25 Powdermet* Part 40¢

Tough, intricate parts ready for assembly without further processing—at *savings of up to 600% over identical machined parts!* No wonder industry chooses Powdermet.*

Low-cost PM parts are die-pressed to close tolerances, have excellent wearability, and a wide range of alloys are available—many exceeding the tensile strengths of mild steel. Through controlled porosity and electrical permeability, many special properties are achieved . . . such as oil-impregnation for life-time self-lubrication. That's why Powdermet* parts are often the *best parts possible* for gears, bearings, filters, etc.

At Yale & Towne, years of experience and technological know-how in powder metallurgy back up every recommendation on PM parts for *your* particular application.

*The world's most famous key . . . symbol of industrial leadership!*

YALE & TOWNE MANUFACTURING COMPANY

PMP Powdered Metal Products Division

9335 Belmont Avenue • Franklin Park, Illinois

Get your copy of this informative new booklet now!

*TRADE-MARK

Send Today For Free Booklet

The Yale & Towne Manufacturing Company
Powdered Metal Products Division
9335 West Belmont Avenue
Franklin Park, Illinois

☐ Send Booklet ☐ Send information on PM parts for attached specifications or drawings.
☐ Have a Yale & Towne Powdered Metal engineer call on me.

Name.....Title.....
Company.....
Address.....
City.....Zone.....State.....

# Here's How TWIN CITY CASTINGS CUT PARTS COSTS 57% on the FOLEY SAW FILER

When you buy Twin City Die Castings, you get a sincere and willing effort to *lower your manufacturing costs* and *strengthen your profit picture.* Here's an example of how Twin City puts *promise* into *practice:*

**THIS WAS THE JOB:**

Produce dies and cast a new hand wheel and rocker arms for America's largest selling Saw Filer, manufactured by Foley Manufacturing Company. Effect simplicity and universality into the hand wheel. Cast rocker arms with cored holes to accommodate pins and set screws.

**THIS WAS TWIN CITY'S ANSWER:**

Die castings replaced machined bronze sand castings. Unit costs were *cut more than 50%.* Design eliminated a third wheel, simplified operation. Threaded steel inserts, cast in place, provide unbeatable wearing qualities. New rocker arms greatly simplified assembly.

**HERE'S WHAT THIS CAN MEAN TO YOU:**

Twin City's experience, plus its ability and willingness to work with your engineers to cut your costs and give you top die casting value, can help you show *new profits* on the products you sell. Oldest die casters in the upper Midwest, Twin City offers a dependable history of service and technical excellence.

Write for the facts or send sample or blueprint. Let Twin City demonstrate its *service plus* to you.

**TWIN CITY DIE CASTINGS CO.**

3351 TALMAGE AVE. S.E. • MINNEAPOLIS 14, MINN.




fabrication data are also given. Grating information includes deflection tables as well as sizes and weights.

(21) HOSE COUPLINGS—Titeflex, Inc., Springfield, Mass. Booklet, 16 pp, describes a quick connect-disconnect coupling for water, oil, steam, gas and chemical lines, which is said to provide permanent freedom from leakage. Also described are single- and double-check valve modifications of this coupling which permit disconnecting lines without shutting down pumps and prevent escape of valuable or hazardous fluids when lines are opened. Coupling accessories, such as right-angle connections and dirt-exclusion covers are also included.

(22) COLD-ROLLED STEELS—Crucible Steel Co. of America, Box 88, Pittsburgh 30, Pa. Booklet, 32 pp, contains up-to-date information on cold rolled specialties, including stainless, alloy, and carbon spring steels. Melting, condition or temper, edge, finish, and packing are also discussed. Included is a brief description of many special purpose items and data showing hardness conversion numbers, decimal equivalents, and weight-size tables.

(23) CENTRIFUGAL PUMPS—Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y. Booklet, "Centrifugal Pump Fundamentals", 12 pp, explains the principles of operation, defines the various terms used in pump calculations and works out typical pump problems. Simple illustrations and comparisons are used or, where necessary, typical problems and curves.

(24) MERCURY RELAYS—Ebert Electronics Corp., Queens Village, 28, N. Y. Catalog 154, 4 pp, contains complete information on UL-approved standard and heavy duty relays, including all characteristics and ratings.

(25) STOCK GEARS, REDUCERS—Ohio Gear Co., 1333 E. 179 St., Cleveland 10, Ohio. Catalog 50, 126 pp. Gear tooth data, horsepower and torque ratings, selection tables and other useful data is provided on standard types of gears, speed reducers, sprockets and roller chains.

(26) PIPE COUPLINGS—H & N Mfg. Corp., 3525 E. 15 St., Los An-

It conquered the climate of the
CONGO
BROOK MOTORS...
ARE BUILT TO CONQUER
YOUR CLIMATIC CONDITIONS, TOO!
In darkest Africa, extreme heat and moisture are among the electric motor's most destructive enemies. It takes motors that are totally weather-proofed during manufacture to stand up to such conditions . . . it took Brook, for fifty years the world's most respected motor, to do the job!
This weather-proofing, a part of Brook's *standard* manufacturing operation, is your assurance Brook motors will perform successfully in *your* climate. Stator slots and windings are impregnated and baked to resist moisture, dust, heat and cold. Every Brook motor is precision built to meet or surpass NEMA standards; uses standard bearings, threads and nuts. All major types are available from stock, in a wide range of horsepower sizes. Brook world-wide service stations have a complete selection of parts . . . Brook motors are easily serviced in *any* shop, anywhere. Be sure to specify Brook . . . the world's *most respected* motor—built by the world's *most experienced* manufacturer. Write for a free catalog today!
1904-1954
. . . . . respected and used the world over
for 50 years!
FAST DELIVERY OF ALL POPULAR MODELS!
Brook has nation-wide sales representation . . . Brook motors are available for quick delivery from strategically located warehouses throughout the U.S. and the rest of the world.
Single phase
world's most respected motor
Splash-proof
Totally enclosed externally fan-cooled
Totally enclosed non-ventilated
Open drip-proof
BROOK MOTOR CORPORATION
BROOK MOTOR CORPORATION
3555 W. Peterson Ave., Chicago 45, Illinois

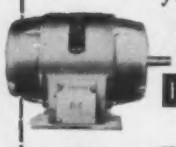
*exclusive*

**REULAND**

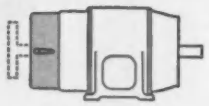
*"Xpandable" design*

*typical adaptations from this*

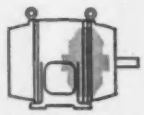
**BASIC DESIGN**



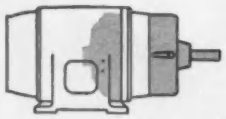
**combines motors • brakes fluid couplings • gear-reducers into tailor-made single-unit POWER PACKAGES!**



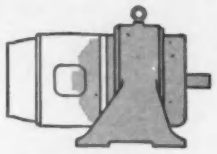
*Motor with Reuland "Through Shaft" magnetic brake*



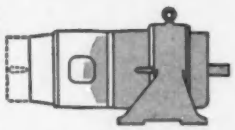
*Motor with internal fluid coupling*



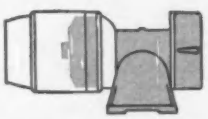
*Motor with fluid coupling and brake on output shaft*



*Motor with fluid coupling and helical gear reducer*



*Motor with fluid coupling, output shaft brake and helical gear reducer (second brake may also be added)*



*Motor with fluid coupling, right-angle worm reducer and brake*

**GREATER COMPACTNESS...**
***one service responsibility!***

Instead of buying and aligning several separate units, install Reuland *tailor-made, single-unit Power Packages.* You save space and weight, reduce prices up to 25% — simplify installation—improve in-the-field performance.

Literally dozens of combinations are available to fit every powering job. All economical, *standard assemblies* using the basic Reuland "XPANDABLE" motor design.

If your equipment utilizes a motor, brake, fluid coupling, gear reducer (or any combination) why not find out first-hand what a Reuland Power Package can do for you. Give us the details and we'll even submit a "tailor-made" test unit on approval.

**OVER 800 "SPECIAL" ELECTRIC MOTOR DESIGNS...**

Still further versatility is provided by the Reuland "Library of Specials." Over 800 motors with special electrical and mechanical characteristics... 800 ways you can save development work, get in production faster!

*Write today, outlining your particular power problem. No obligation, of course.*

**REULAND ELECTRIC COMPANY**
*Distributors in all principal cities*

**WESTERN DIVISION: Alhambra, California • EASTERN DIVISION: Howell, Michigan**

**Catalogs and Bulletins.....continued**

geles 23, Calif. Catalog 234L, 4 pp, gives details on a ball-bearing, swivel-type fitting for low pressures.

(27) RIGHT-ANGLE GEAR DRIVES—Airborne Accessories Corp., 1414 Chestnut Ave., Hillside, N. J. Catalog 4 pp, lists specifications for both sizes of drives: the ⅓ hp unit and the 1 hp unit. These two basic models meet the requirements of virtually all applications for right-angle gear drives. Both are strong enough for use with either manual or power-operated systems.

(28) SILICON TRANSISTORS—Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Texas. Bulletins, 2 pp, describe general purpose silicon transistors and a medium power silicon transistor.

(29) PNEUMATIC EQUIPMENT—Mead Specialties Co., Chicago, Ill., Catalog, 52 pp, describes air-operated devices such as air cylinders, air clamps (single and double-acting air cylinders), presses, workfeeders, vises, collets, drill press feeds, column presses, timers, impact hammers and valves.

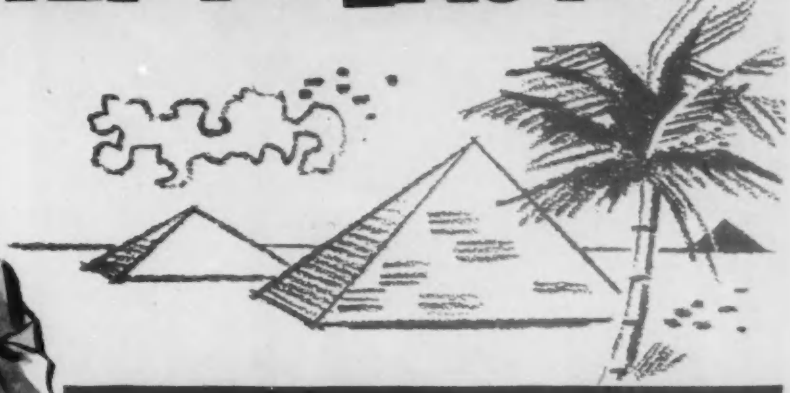
(30) CENTRIFUGAL PUMPS—Deming Co., Salem, Ohio, Bulletin 4011, 12 pp. Contains data on equipment ranging from 1 to 5-in. discharge; capacities up to 1,000 gpm, maximum heads up to 250 ft. Units furnished with electric motor for belt drive or pump only.

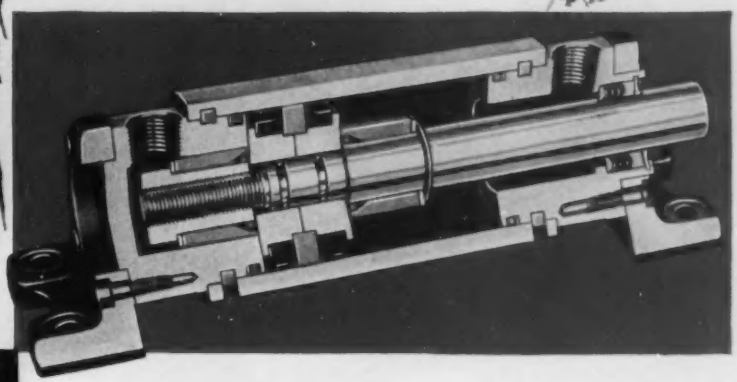
(31) CORROSION-RESISTANT COATING—Carboline Co., 331 Thornton Ave., St. Louis, Mo. Bulletin 400, 4 pp, describes a flexible coating, unplasticized and available in a limited range of colors. Application is similar to that required by vinyls but resistance to acids, alkalies and solvents is said to be materially greater.

(32) PANEL INSTRUMENTS—General Electric Co., Schenectady 5, N. Y. Bulletin GEC-368F, 12 pp, contains description, construction and application details of both d-c and a-c instruments. Dimensions and price information also given as well as physical, operational, and electrical data.

(33) CAPACITORS—Illinois Condenser Co., 1616 N. Throop St., Chicago 22, Ill. Catalog, 15 pp. Electro-

# BUILT TO LAST...





## O-M CYLINDERS *(air-hydraulic)*

***Designed and engineered with the user in mind,*** O-M Cylinders embody every essential construction and mechanical feature to assure trouble-free performance and long service.
***They are built of steel*** with bearing surfaces of bronze—precision machined with modern equipment.
***Cylinder bores are honed to a fine finish,*** and the hi-tensile piston rods are polished to give long life and smooth performance.
***Effective O-ring static seals are backed up to prevent extrusion*** under high pressures. All packings are self-adjusting and are carefully selected for proper usage.
***A rigid inspection*** at the factory is your guarantee of peak performance.
***O-M Cylinders fit where others won't*** because O-M special interlocking mechanism eliminates bulging tie rods and end caps.
***Available in a full range of sizes*** (1½" to 8" bores) with standard, 2 to 1 or oversize rods. *14-day delivery on most sizes.*

## fit where others won't

## Mail coupon now!

*for FREE catalog* and complete set of ½ and ¼-scale templates showing all cylinders and mounting brackets.

**ORTMAN-MILLER MACHINE COMPANY**
**1218 150th Street, Hammond, Indiana**

☐ Have representative call
☐ Please send latest O-M Catalog ☐ Complete Templates

Name _____ Position _____
Company _____
Address _____
City _____ Zone _____ State _____

WHAT'S YOUR CLAMPING PROBLEM?
WITTEK
HAS THE ANSWER
Here is a selection from among the many different types and sizes of hose clamps designed and manufactured by WITTEK. Whatever the hose connecting problem, it's a safe bet that WITTEK (leader for over a quarter century) has the exact type and size clamp to do the job right! Let WITTEK help solve your clamping problems. Write today.
5187
WITTEK MANUFACTURING COMPANY
4338 West 24th Place • Chicago 23, Illinois



lytic capacitors of various types and styles are described and illustrated.

(34) HEAT AND CORROSION RESISTANT CASTINGS —Alloy Casting Institute, 32 Third Ave., Mineola, N. Y. Folder, 4 pp, has revised chart of chemical composition ranges. Designation changes and several additional alloys, including most popular grades of nickel-chromium compositions, are incorporated in chart.

(35) TROLLEY BUSWAY ELECTRIFICATION SYSTEMS—Feedrail Corp., 125 Barclay St., New York 7, N. Y. Bulletin 45, 60 pp, illustrates and describes track, trolleys and accessories used in the safe electrification of light tonnage cranes and hoists, assembly and production lines, moving test lines, portable and machine tools, lighting, sewing, cutting rooms.

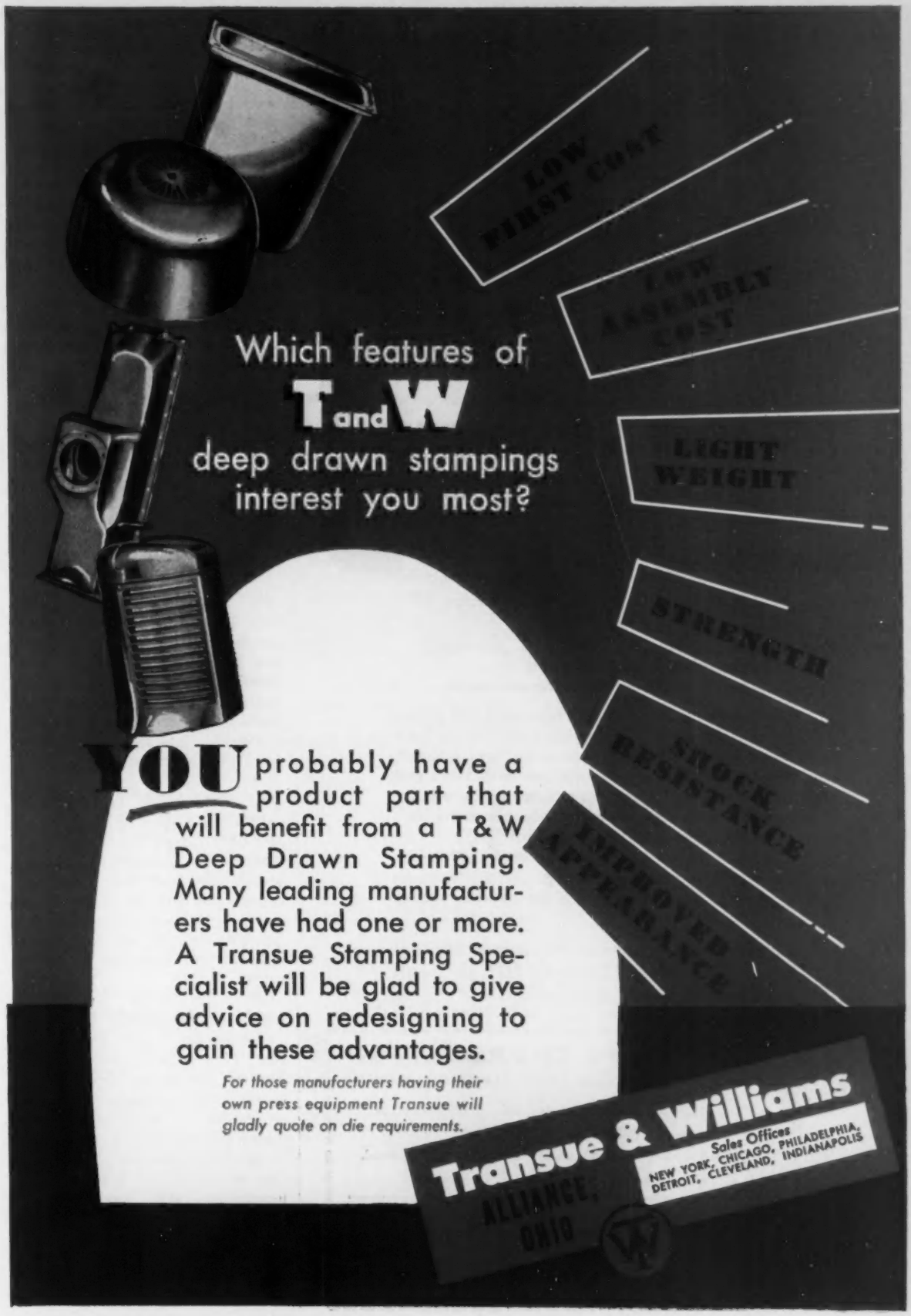
(36) PLUG-IN COMPONENTS, DATA COMPUTERS—Servomechanisms, Inc. 500 Franklin Ave., Garden City, N. Y. Brochure, 12 pp, describes latest developments, such as mach computers, master air data computers, accelerometers, positioning mechanisms.

(37) TEST INSTRUMENTS—Commercial Research Laboratories, Inc., 20 Bartlett Ave., Detroit 3, Mich. Catalog. Detailed descriptions of equipment such as air flow measuring devices, engine indicators, flowmeters, test stands, magnetic thickness gages, pressure and vibration measures.

(38) CHEMICAL PORCELAIN—Lapp Insulator Co., LeRoy, N. Y. Bulletin 438, 4 pp. The usefulness of porcelain as a material of construction is described with specifications on chemical and physical characteristics. Included are "Y" and angle valves, safety valves, plug cocks, pipe and fittings, towers, tower plates and nozzles, and raschig rings.

(39) HEAT-TREATED STEEL—Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa. Booklet, 8 pp, describes, with pictures, heat treating method for cold-finished steel bars and gives properties available in material processed in this equipment.

(40) TOGGLE CLAMPS — West Point Mfg. Co., 26935 W. Seven Mile


LOW FIRST COST
LOW ASSEMBLY COST
LIGHT WEIGHT
STRENGTH
SHOCK RESISTANCE
IMPROVED APPEARANCE
Which features of
T and W
deep drawn stampings
interest you most?
YOU probably have a product part that will benefit from a T&W Deep Drawn Stamping. Many leading manufacturers have had one or more. A Transue Stamping Specialist will be glad to give advice on redesigning to gain these advantages.
For those manufacturers having their own press equipment Transue will gladly quote on die requirements.
Transue & Williams
ALLIANCE, OHIO
Sales Offices
NEW YORK, CHICAGO, PHILADELPHIA, DETROIT, CLEVELAND, INDIANAPOLIS

**The headaches caused by threaded fastenings — soft materials, corrosion, frequent use—are banished immediately with *Heli-Coil** Screw Thread Inserts.**

Thousands of manufacturers have used and proved them. ***Heli-Coil*** Inserts provide much greater loading strength for your threads, make threads so perfect they will never wear, strip, seize, corrode, gall. With ***Heli-Coil*** Inserts you can use fewer, smaller, shorter fastenings and lighter, cheaper materials... this saves you space, weight and MONEY.

Check today on how and why ***Heli-Coil*** Screw Thread Inserts are the answer to the designer's prayer. Just mail the coupon for full information and samples.

***Heli-Coil* Inserts conform to official Military Standards MS-122076 (ASG) through MS-124850 (ASG) and others.**

*Reg. U. S. Pat. Off.

**HELI-COIL CORPORATION**
148 SHELTER ROCK LANE, DANBURY, CONN.

☐ Send samples and Bulletin 689 — Military Standard Sheets.
☐ Please have a *Heli-Coil* Thread Engineer call.
☐ Send samples and Handbook 652, a complete design manual.

NAME_____ TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE____ STATE_____ 2710




Road, Detroit 19, Mich. Booklet, 8 pp, describes work-holding devices for welding, drilling, reaming, bonding, plate and sheet fabricating, woodworking and general assembly.

(41) TEMPERATURE CONTROLS —Burling Instrument Co., 16 River Road, Chatham, N. J. Bulletin 103, 2 pp, covers models used for controlling temperatures or as high or low temperature safety alarms and cut-outs up to 1000 F. Included are complete descriptions of operation, dimensions, methods of mounting and operating specifications.

(42) CIRCUIT BREAKERS—Heinemann Electric Co., 725 Plum St., Trenton, N. J. Booklet, 24 pp, describes the principle, design and operation of hydraulic-magnetic circuit breakers. Included are time delay curves, impedance charts and other data. Photographs and diagrams illustrate the text.

(43) AIR CONTROL, CLEANSING, LUBRICATION—Air Conversion Research Corp., 4107 N. Damen Ave., Chicago 18, Ill. Catalog, 16 pp, describes purifying, lubricating and controlling devices for air systems. Illustrated with photographs and engineering drawings and includes manufacturer's specifications.

(44) HEAT FLOW TRANSDUCER —Beckman & Whitley, Inc., 925 E. San Carlos Ave., San Carlos, Calif. Leaflet, 2 pp, illustrates and describes Model 200 heat flow transducers. Cross-section drawings, output calibration curves and specifications providing data on sensitivity, response, internal resistance and dimensions are all included.

(45) PLASTER-MOLD CASTINGS —Airtron, Inc., 1103 W. Elizabeth Ave., Linden, N. J. Circular, 4 pp. The text stresses the ability of this casting process to maintain tolerances of $\pm 0.002$ in. of dimension. How casting patterns may be modified for design changes and how improved surface conditions and better electrical performance result from eliminating soldering and bending operations are also included.

(46) CENTRIFUGAL PUMP — De Laval Steam Turbine Co., Trenton, 2,

N. J. Bulletin, 4 pp, illustrates ease of maintenance and service features of these pumps. A full-page, cut-away diagram of the new pump is included. Specification data describes in detail the design and construction of all major parts.

(47) FLOW CONTROL VALVES—Vickers Inc., 140 Oakman Blvd., Detroit 32, Mich. Bulletin 53-35, 4 pp. contains flow control circuits, performance curves, installation data and specification tables. Gasket-mounted valves in a series of models for $\frac{1}{4}$, $\frac{3}{8}$, $\frac{3}{4}$ and $1\frac{1}{4}$-in. standard pipe sizes are described, which provide adjustable metered flow capacities from 5 cu in. per min to 65 gpm.

(48) SQUIRREL CAGE INDUCTION MOTORS—Reliance Electric & Engineering Co., 1088 Ivanhoe Road, Cleveland 10, Ohio. Bulletin B-2102, 12 pp, describes motors ranging from 1 to 200 hp. Performance characteristics, construction features, dimensions, price and other information are also listed.

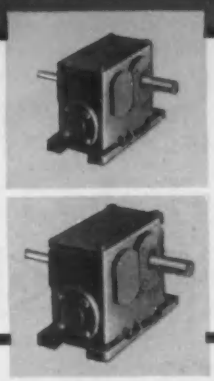
(49) MECHANICAL INSTRUMENTS—Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J. Catalog M-2-A illustrates and gives complete basic information on this line of mechanical industrial instruments, including fixed stem and distant-reading dial thermometers, temperature and pressure recorders, non-indicating controllers, indicating and recording controllers, as well as accessories and diaphragm motor valves.

(50) PLASTICS—Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. Catalog, 50 pp, on industrial Micarta plastic covers all grades and forms supplied and the chemical, mechanical and electrical properties of each. Color-keyed, the handbook also provides design and application information in relation to directional loads. The machining data section provides the designer and user with up-to-date fabrication procedures for such operations as punching, shearing, sawing, tapping, milling, stamping and engraving.

(51) PRINTED CIRCUITS—Photocircuits Corp., Glen Cove, N. Y. Brochure, 8 pp. Lower wiring costs,


Packaging 15 products per minute in sanitary, see-through "skins"

...STOKES & SMITH STRETCHRAP MACHINE USES 2 WINSMITH SPEED REDUCERS



Wrapping tight, wrinkle-free "skins" of transparent Pliofilm to the contours of meats, cheeses, fruits, vegetables, toys, soap, etc., the Stokes & Smith Stretchrap Machine packages up to 15 odd-shaped products per minute.

Fed from a roll, the Pliofilm is first heated, then stretched and drawn by vacuum into a pocket to receive the product. Driving the cam shaft that actuates the air valves controlling the operation of the machine is a motor-powered, Winsmith Worm Gear Speed Reducer, Model 2 DB, with an input speed of 1350 rpm and a reduction ratio of 25:1.

Carrying a steady stream of contour-wrapped products from the machine, the conveyor is driven by another Winsmith Reducer, Model DB, which is powered by the same main drive 3 HP motor. With an input speed of 1440 rpm, it operates at a 50:1 reduction ratio.

In stressing advantages of Winsmith Reducers, Stokes and Smith Company states, "They have worked in nicely with our space limitations."

Compactness, coupled with ruggedness, have been key factors in establishing the Winsmith name, *plus this fact:* The Winsmith line fulfills any speed reduction need throughout the 1/100 to 85 hp range in ratios from 1.1:1 to 50,000:1. Request Catalog 148 for details.

WINSMITH, INC.
111 Eaton St.
SPRINGVILLE (Erie County), N. Y.

EQUIPPED WITH WINSMITH SPEED REDUCERS

MEMBER OF AGMA

# Here are 3 PROVEN ANSWERS to your timing problems

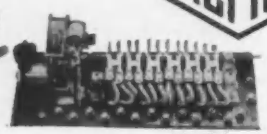
1

AEMCO

## AUTOMATIC RESET TIMER

Opens or closes circuits for intervals of seconds or hours, recycling immediately or holding a circuit for a fixed interval before recycling. Stock models available with fixed or adjustable settings. In case of current interruption unit will recycle or hold position and recycle with return of current.

2



AEMCO

## SEQUENCE TIMER

Engineered to meet requirements for the individual timing of a series of operations. All circuits are 15 amp., have positive quick make and break pure silver contacts. Friction clutch between cam shaft and motor gear train may be manually adjusted at any time desired. Automatic Sequence Timers may be supplied in SPST or SPDT . . . are carefully engineered to meet exacting specifications.

3

AEMCO

## CYCLE MASTER

This low-cost Automatic Time Switch can be set for as many as 48 ON and OFF operations per revolution of the dial. Unit has a 15 minute minimum ON or OFF interval on 24 hour cycle unit . . . 7½ minute interval on 12 hour cycle models and as little as 37½ second intervals on 1 hour cycling models. All models will control up to 48 ON and OFF operations during cycle. Available with Sunday and holiday cutout in 10 or 20 amp. capacity . . . four to eight terminal panel.

AEMCO

## ENGINEERED RELAYS

AEMCO also manufactures a complete line of quality relays . . . open and sealed type, midgets and miniatures . . . plug-in base or specialized mountings . . . an almost limitless variety of spring and coil combinations. AEMCO Relays exceed specs . . . *military or industrial!* Specialized units engineered and manufactured to meet particular requirements and specifications.

*Why not write us today? The services of our skilled engineering staff are at your disposal.*

AEMCO

*Automatic Electric* MFG. CO.

66 STATE STREET · MANKATO, MINN.




reduced assembly time, reproducibility, improved reliability, miniaturization and product improvement are among the advantages advanced for this method of construction. Includes information on methods of application, materials, electrical characteristics. Assembly with dip soldering and plated-through holes is described.

(52) AIRCRAFT BOOSTER PUMP AND PRESSURE REGULATOR—Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich. Bulletin A-5226, 4 pp, describes a new flow-sensitive pressure regulator. Engineering drawings of unit and a typical installation provided, as well as a performance curve. Bulletin A-5228, 4 pp, is about a new, hydraulic-motor driven booster pump for aircraft. Unit and its use is illustrated with photographs, drawings and curves.

(53) ELECTRONIC COMPONENTS—I-T-E Circuit Breaker Co., 19 and Hamilton St., Philadelphia, 30, Pa. Catalog, 36 pp, describes subminiature resistors, precision and power resistors, camera and receiver-type deflection yokes, focus coils, and IF and RF transformers and coils. Charts, tables, drawings as well as selection and application information.

(54) PHOTORECORDING PAPERS AND FILMS—Eastman Kodak Co., Rochester 4, N. Y. Leaflet, 4 pp. Describes the photographic characteristics and the large variety of winding specifications available in papers and films for use in oscillographs and other recording instruments. Data are given on the light sensitivity of all the materials and on their thickness. Photographs illustrate the cores and spoolings. Processing recommendations are also included.

(55) INVESTMENT CASTINGS—Hitchener Mfg. Co., Milford, N. H. Booklet, 12 pp, contends that, when all cost factors (amortization of tools, cost of secondary machining or finishing operations, assembly) are considered, the true cost of investment castings is often very low in either large or small quantities. An actual comparison of the operations involved in the fabrication of a production part by machining from bar stock and by investment casting is presented as a means of determining savings that this company

DU PONT

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 5 — 1954

# Windshield-wiper Motor of Du Pont "Zytel"* Nylon Resin Shows No Wear after 9,500,000 Cycle Test

## Du Pont LUCITE® gives long-lasting sparkle to molded parts

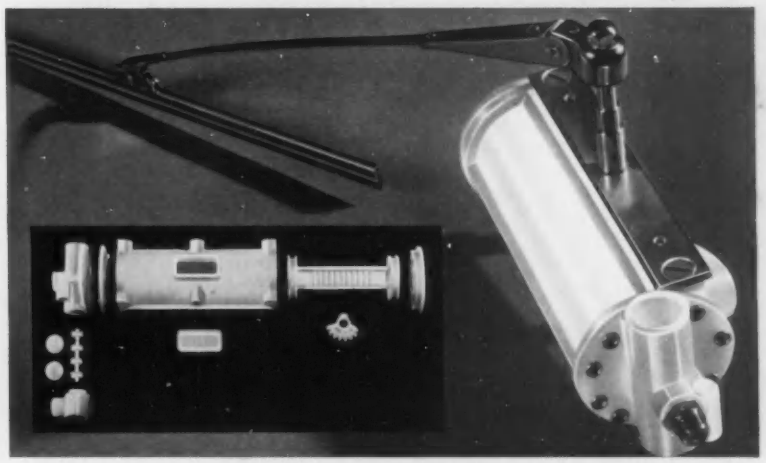
DU PONT "Lucite" acrylic resin has optical and mechanical properties which make it a versatile engineering material. "Lucite" is readily injection-molded,

**A clear, shatter-proof, corrosion-resistant tail-light lens of Du Pont "Lucite". The wide range of applications for "Lucite" acrylic resin in the automotive field are indicative of the usefulness of this material to the design engineer.**

providing economical production of parts, in simple or complex shapes. This engineering material has unique "light-piping" and "edge-lighting" qualities, and is available in a wide range of colors.

(*Continued on Page 2, Column 1*)

## Unique engineering material has outstanding abrasion resistance and is lightweight and dimensionally stable.



**Exploded view of air-pressure windshield-wiper motor of Du Pont "Zytel" nylon resin. These parts resist corrosion and are lightweight. They are injection-molded and require no finishing operations. The manufacturer is Sprague Devices, Inc., Michigan City, Indiana. Molder is Danielson Company, Danielson, Conn.**

WINDSHIELD-WIPER failure on a truck can mean costly delay. Now an air-pressure wiper motor has been developed that's much less subject to failure than old-style motors. Its parts are molded of Du Pont "Zytel"* nylon resin.

This motor weighs only 10 ounces—yet is so durable that the manufacturer claims it will outlive any truck. In a grueling test, the motor operated two wiper arms and blades for 9,500,000 cycles. Afterwards, the parts of abrasion-resistant "Zytel" showed no perceptible wear.

Corrosion, too, is no problem with "Zytel". And the motor parts won't leak air—keep dimensionally stable when exposed to temperature and humidity changes.

### *No Finishing Necessary*

Parts for this motor are mass-produced by precision injection molding. Their smooth, resilient surfaces are ideal for handling moving seals. The manufacturer can keep down production costs because expensive surface-finishing operations are eliminated.

Have you and your company investigated the properties of Du Pont "Zytel" nylon resin? The application shown here is typical of the prod-

(*Continued on Page 2, Column 1*)

*"Zytel" is the new trade-mark for Du Pont nylon resin.

OVER

## Construction well along on $3,000,000 Polychemicals laboratory in Wilmington

DU PONT is building a $3,000,000 Sales Service Laboratory in Wilmington, Delaware, to expand the present facilities of its Polychemicals Department. This new laboratory is to provide sales and engineering services to customers in the plastics and other industries.

The laboratory will have the most modern equipment available for developing technical data on the use and processing of Polychemicals Department products. Its facilities for providing technical services, especially in the field of plastic engineering materials such as "Alathon" polyethylene resin, "Teflon" tetrafluoroethylene resin, "Lucite" acrylic resin, and Du Pont "Zytel" nylon resin, will be several times those of the present laboratory in Arlington, N. J.

Parts of the new laboratory will be equipped especially for study courses on the utilization of new plastic engineering materials. Space for exhibits of these materials and products made from them is provided in a two-story reception area.

Large portions of the laboratory will be equipped for demonstrating new processing methods and for testing. Total floor space: 62,000 square feet.

Preliminary work on the site is now under way and construction is expected to be completed late in 1954.

DU PONT

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

# PRODUCT ENGINEERING NEWS

NO. 5 — 1954

## Wiper Motor of "Zytel"

(*Continued from Page 1*)

uct improvement possible when the properties of this unique engineering material are evaluated in terms of design and service requirements. For further information, clip the coupon.

## Du Pont "Lucite"

(*Continued from Page 1*)

### *Stays Clear and Sparkling*

Du Pont "Lucite" has exceptional outdoor stability . . . stays clear and sparkling when constantly exposed to sunlight and moisture. Also, lightness of weight and shatter-resistance are desirable features of Du Pont "Lucite".

### *Easily Molded*

"Lucite" is readily molded or extruded to desired shapes. There are many applications for "Lucite" such as automotive, medical, illumination, decorative, to mention a few. For complete information on this versatile member of the Du Pont family of plastic engineering materials fill in the coupon on this side of this page today.

### Investigate Du Pont engineering materials in your product development programs

ONE of the family of these versatile engineering materials is often a key factor in product improvement or new product design.

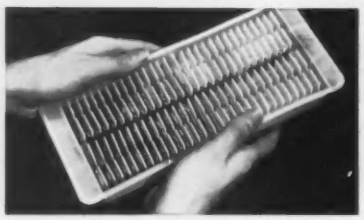
The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"** nylon resin are helping solve industrial design problems.

### NEED MORE INFORMATION?

CLIP the coupon for additional data on properties and applications of these Du Pont engineering materials.

## New flexible ice tray made of Du Pont "Alathon"

DU PONT "Alathon" polyethylene resin has again demonstrated its versatility—this time as a flexible ice tray that supplies chipped ice when it's twisted. The Gits Molding Corp., manufacturers of "The Chipper", report they are using "Alathon" 10 for this ice tray because this Du Pont engineering resin material offers advantages found in no other material.



**Chipped ice at her fingertips—with a simple twist of this tray of "Alathon" polyethylene resin. "The Chipper" is made of Du Pont "Alathon" 10 by Gits Molding Corporation, Chicago, Illinois.**

### *Properties of "Alathon"*

Du Pont "Alathon" stays flexible at temperatures well below those at which the ice tray is used. "Alathon" is warm to the touch . . . more pleasant to handle. "Alathon" contains no plasticizer—it won't affect the taste of the ice, and is odorless and non-toxic. These "Chipper" trays are mass-produced by the economical injection-molding technique.

### *Can "Alathon" Help You?*

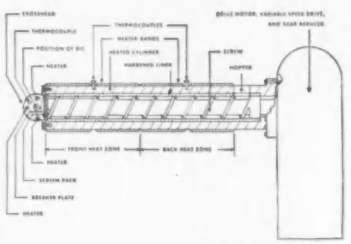
If you have a design problem, perhaps Du Pont "Alathon" polyethylene resin is just the material you've been looking for. Every day, designers are finding more and better ways to use this versatile engineering material. For complete information on the properties and applications of "Alathon", use the coupon.

## POINTERS ON PROCESSING

### *Forming by Extrusion*

DU PONT "Zytel" nylon resin, "Teflon", "Alathon" and "Lucite" all can be formed by extrusion techniques. Basically, screw extrusion consists of placing the granulated material in a hopper where it is moved down and forward along a one-piece heating barrel by means of a rotating screw. The screw then forces the softened material through a die, forming it into shapes such as tubing, rod, bars, and other shapes. This operation varies in a minor degree with the material being processed. Screw extrusion is applicable to "Alathon", "Lucite" and "Zytel".

A typical extrusion machine for "Zytel" nylon resin has these features:



### *Extrusion of "Teflon"*

Extrusion of "Teflon" is best carried out by the ram extrusion method. A reciprocating ram in a cylinder compacts successive charges of "Teflon". The powder is introduced through a hopper at the back position of the ram. Preforming takes place at a cold section of the cylinder and the compacting material moves through the heated section of the cylinder where it is sintered.

Extrusion has certain economic advantages where continuous lengths of material are desired. For example, a coating of "Zytel" nylon resin used as a primary insulation on small wire can be applied at speeds up to 1600 feet per minute with suitable take-off equipment.

**E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT**
**Room 108, Du Pont Building, Wilmington 98, Delaware.**

*Please send me more information on the Du Pont engineering materials checked:* ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for:*_____

NAME_____ POSITION_____

COMPANY_____

STREET_____

CITY_____ STATE_____

TYPE OF BUSINESS_____

**"Alathon", "Lucite", "Teflon" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)
*"Zytel" is the new trade-mark for Du Pont nylon resin.

states may be realized. Pictures show investment casting methods from the building of dies to inspection and gaging of the finished casting.

(56) CLUTCH COUPLING UNITS —Formsprag Co., Van Dyke, Mich. Brochure, 4 pp, gives dimensional data, service factors and all other application engineering data necessary to specify the right clutch-coupling unit.

(57) MICROWAVE TEST EQUIPMENT—F-R Machine Works, Inc., 44-14 Astoria Blvd., Long Island City 3, N. Y. Catalog describes probes, tuners, frequency meters, tees, analyzers, and amplifiers. Leatherette binders are available on request.

(58) ELECTRONIC DATA SHEET —G. H. Leland, Inc., Dayton 2, Ohio. Circuits using relays and rotary solenoid are illustrated and described as they occur in actual applications. This is the first issue of monthly publication.

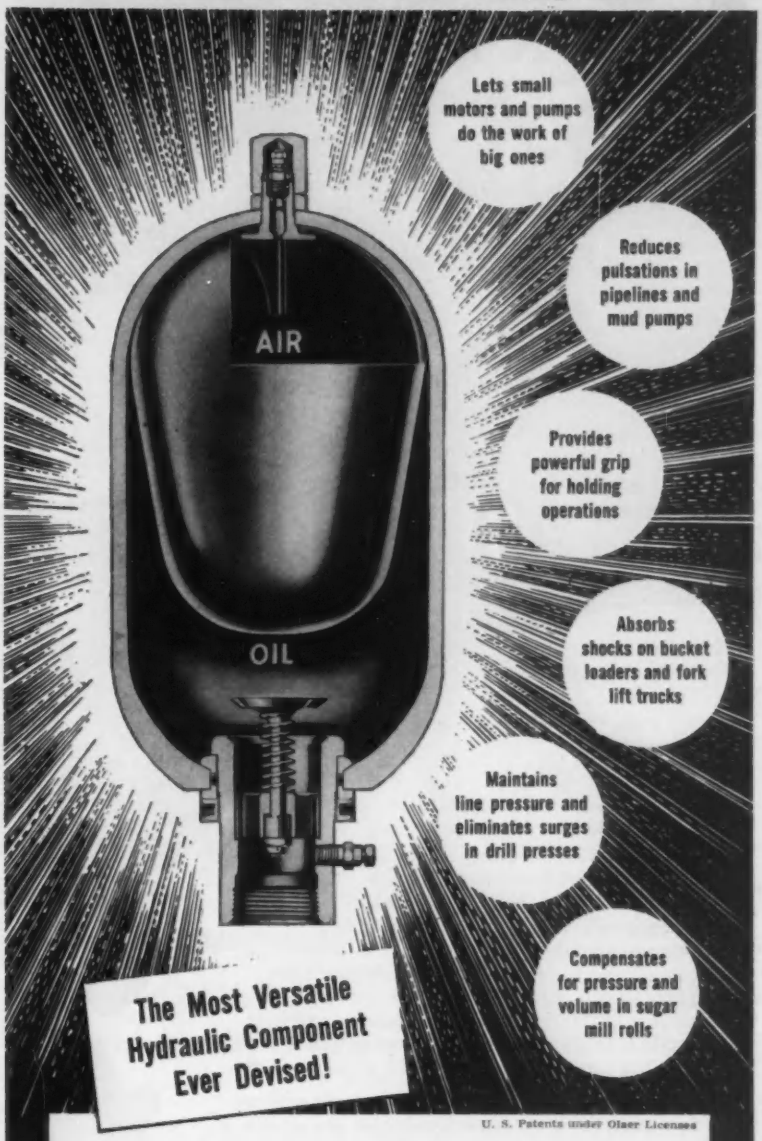
(59) SURFACE ACTIVE AGENTS —American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y. Booklet, 44 pp, contains a discussion of surface chemistry, facts about grades of active agents currently available and toxicity data.

(60) AIRCRAFT LOCKNUTS — Boots Aircraft Nut Corp., Norwalk, Conn. Catalog, 60 pp, describes different types of aircraft lock nuts available to meet particular specifications needed by the aviation and allied industries. In addition, information is included on a new type of tapped hole and self-locking insert. These provide reusable threads in blind holes and are specifically engineered for use in thin sections of steel or aluminum or thick sections of plastics, castings or wood.

(61) RESISTORS AND RHEOSTATS—Tru-Ohm Products, 2800 N. Michigan Ave., Chicago 18, Ill. Catalog, 20 pp. Descriptions, photographs, listings and selection data on resistors and rheostats are given. Details on a type of ceramic welding nozzle also included.

(62) TEMPERATURE CONTROL ACCESSORIES — West Instrument Corp., 525 N. Noble St., Chicago 22, Ill. Catalog uses example and tables


# THE GREER ACCUMULATOR


Lets small motors and pumps do the work of big ones
Reduces pulsations in pipelines and mud pumps
Provides powerful grip for holding operations
Absorbs shocks on bucket loaders and fork lift trucks
Maintains line pressure and eliminates surges in drill presses
Compensates for pressure and volume in sugar mill rolls
AIR
OIL
The Most Versatile Hydraulic Component Ever Devised!

U. S. Patents under Olaer Licenses

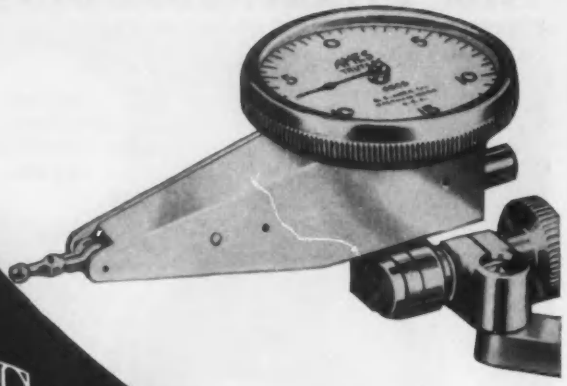
Today, Greer Accumulators are found in every conceivable hydraulic circuit – the few applications mentioned above show tremendous diversity of use. Their wide acceptance is due to these important reasons. 1) simple operation, 2) ease of installation, 3) minimum maintenance, 4) *and complete safety*. They are rugged and dependable, too – each built to take many times the expected work load.

Let our experienced application engineers show you how a Greer Accumulator can reduce the cost, size, weight and complexity of your hydraulic equipment. Our Brochure 301-A gives you technical data on the Greer Accumulator. Write or call today for your free copy. No obligation.

GREER HYDRAULICS INC. • International Airport • JAMAICA 30, NEW YORK

Field offices in Chicago, Dayton and Detroit • Sales Representatives in all principal cities

...to obtain cost reduction...



AMES uses HITCHINER precision investment castings

The B. C. Ames Co., Waltham, Mass., producers of some of the world's most accurate micrometer dial gauges, is another leading manufacturer who has found that accurate HITCHINER INVESTMENT CASTINGS reduce production costs by eliminating expensive machining operations. The Ames "Trutest" case is a typical Hitchiner bronze casting held to such close tolerances that finishing operations are kept to a minimum. To make this part from the solid or to use another type of casting would mean prohibitive expense, according to the Ames Company.

HITCHINER INVESTMENT CASTINGS permit, with only a few exceptions, complete freedom in the choice of ferrous or non-ferrous metals. The Ames Company chose beryllium copper for the clamp castings to gain proper metal density, freedom from fatigue, and longer life at much lower costs than machined steel clamps.

If you use small castings, your company, like Ames and many others, may be able to cut cost of components through HITCHINER INVESTMENT CASTINGS. We'll be glad to furnish prompt quotations on receipt of your prints. WRITE FOR FREE BOOKLET TODAY TO —

HITCHINER Manufacturing Company, Inc.
MILFORD 4, NEW HAMPSHIRE
Representatives in principal cities.



to help determine the type of thermocouple and protective tube needed for virtually any operation. Data are based on ISA "Recommended Practice 1.1" of Jan. 19, 1949. The outer margin of each page is indexed for fast reference to other sections of the catalog. Each item is priced. Illustrations are drawings for clarity. The last two pages are tabulated for maintaining stock records with provisions for listing the machine, thermocouple catalog number, description, previous purchase order number, and maximum, minimum and in-stock headings.

(63) CAST STAINLESS CHARACTERISTICS—Cooper Alloy Foundry Co., Hillside, N. J. Booklet of eleven reference sheets covering the major stainless alloys covers chemical composition, mechanical and physical properties, resistance to major corrosive solutions, machinability, heat treatment and weldability. In addition, the equivalent ACI, AISI, SAE and ASTM designations are given.

(64) PRESSURE TRANSDUCERS—Statham Laboratories, Inc., Los Angeles, Cal. Bulletin PT-1, 12 pp, describes instruments for the measurement of gage, differential, and absolute pressures. Drawings, specifications and selection tables for eight designs for pressure measurements from 0-0.05 to 0-10,000 psi are included.

(65) HYDRAULIC COMPONENTS—Hydraulic press Mfg. Co., Mount Gilead, Ohio. Catalog 1101, 28 pp, illustrated and planned to provide quick recognition of general specifications. Pumps, motors, power units, cylinders, valves and hydraulic circuit cylinders are described and illustrated and general specifications are provided.

(66) REVOLVING JOINTS—Rotherm Engineering Co., Inc., 7280 Devon Ave., Chicago 31, Ill. Catalog 11, 4 pp. Cross-sectional drawings, tables of dimensions and other data are used to describe line of revolving joints for use in rolls, mills, cans, slashers, calenders using steam, air, oil, gas or water at sub-zero to elevated temperatures.

(67) MICROMETERS—George Scherr Co., 200 Lafayette St., New

York 12, N. Y. Pamphlet, 4 pp. Includes illustrations of micrometers being adjusted for wear by an exclusive method, of micrometers being checked for accuracy with gage blocks and for parallelism with optical parallels, of a toolsstand used for clamping a micrometer, of micrometer sets in various combinations and of depth micrometers. A price list inserted in the pamphlet contains, in addition to prices on all items in the pamphlet, a listing of gage blocks in three types of sets.

(68) ELECTRONIC COMPONENTS — Micamold Radio Corp., 1087 Flushing Ave., Brooklyn 37, N.Y. Bulletin 107, 4 pp, illustrates 11 types of interference filters and noise suppression capacitors. Power ratings and attenuation characteristics, three curves of typical attenuation characteristics as measured in MIL-STD-220 for a 50-ohm system, are also included. Bulletin 108 deals with pulse forming networks and delay lines. The operating principle of these units, common applications and construction details are described. Typical circuits showing the arrangement of multiple capacitor and coil sections are presented.

(69) TEST DUMMY—Alderson Research Laboratories, Inc., 10 E. 38 St., New York 16, N. Y. Brochure, 11 pp. Design, construction and specifications of anthropomorphic test dummy are discussed and how it may be used for investigations of the effects of blasts, acceleration and crash effects on the human body are described.

(70) ALUMINUM CASTING ALLOYS—Apex Smelting Co., 2537 W. Taylor St., Chicago 12, Ill. Brochure, 6 pp. Properties of an aluminum-base alloy series for high-strength castings without heat treatment are given together with a discussion of its castability and machinability. High machinability of Ternalloy, which approaches 5,000 sfm, is explained and compared with various other metals and alloys.

(71) TRANSFORMERS — United Transformer Co., 150 Varick St., New York 13, N. Y. Catalog A, 26 pp, describes transformers for broadcasting, amateurs, laboratory and replacement purposes. Also included are reactors, filters and magnetic amplifiers for military equipment.

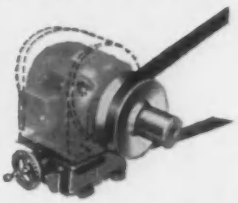

REEVES

Vari-Speed Motor Pulley

Smaller Units!
More HP!

Completely new redesigned line from ½ to 15 HP!

"spiral-groove" lubrication



For new or old NEMA Motors

CHECK ALL THESE NEW REEVES FEATURES

1 New, smaller disc assemblies are engineered for new NEMA Motors, yet usable with old.

2 New spiral-groove lubrication assures complete lubrication for years of rust-free, trouble-free service.

3 One-point lubrication. Unit can be lubricated when stopped, or *while in operation.*

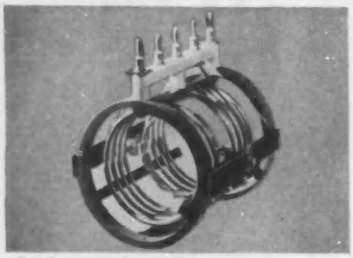
4 Superior base construction provides greater rigidity and strength, reduces vibration and noise.

REEVES PULLEY COMPANY • COLUMBUS, INDIANA

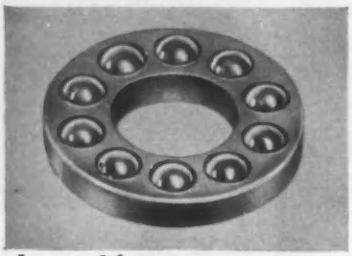
Write for complete details and new bulletin today! Specify K8b-V545.

SYNTHANE

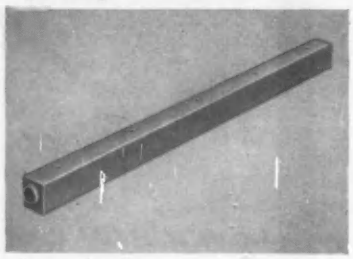
laminated plastics at work



**In broadcasting** This air inductor coil is used in radio and television broadcasting. Its Synthane end rings act as insulators, strong supports.



**In machinery** Synthane ball bearing retainers are standard in many different types and brands of ball bearings. Synthane is mechanically strong, almost friction-free, light in weight.



**In plating equipment**

Plating barrel parts are made of Synthane because of its combination of properties. It's machinable, resistant to acids and alkalis, and it has high dielectric strength.

*What's your* ***PROBLEM?***

***MAIL COUPON FOR FREE FOLDER***

*Our 25th Year*

**SYNTHANE CORPORATION**

4 River Road, Oaks, Pa.

Please send me your free folder describing advantages, properties, uses, and kinds of Synthane plastics.

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

# MEETINGS

Aug. 23-Sept. 3

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, Mass. A two-week special summer program in the Automatic Control of Machine Tools. Morning Sessions will be devoted to studies of systems and components. Afternoon sessions will cover programming techniques, using the numerically controlled milling machine developed in the servomechanism laboratory. Tuition for the course is $160.

Aug. 25-27

WESTERN ELECTRONICS SHOW & CONVENTION, Los Angeles Pan-Pacific Auditorium. The show and convention are sponsored by The West Coast Electronic Manufacturers Association and The Los Angeles and San Francisco sections of the Institute of Radio Engineers.

Sept. 1-16

INTERNATIONAL ELECTRO-TECHNICAL COMMISSION, University of Pennsylvania, Phailadelphia, Pa. The Golden Jubilee Meeting, the commission seeks a better understanding between electrical engineers of various countries with common means of expression and standards for electrical machinery and apparatus.

Sept. 8-10

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Fall Meeting, Milwaukee, Wis. The titles of some of the papers are: "The electromagnetic clutch—its operation, application and control"; "Performance operator;" "Design of power spur gears for minimum inertia;" "The geometry of crossed helical involute gears;" "Approximate synthesis of four bar linkages;" "Semi-graphical solution of acceleration of plane cam driver roller followers and four bar linkages."

Sept. 13-16

SOCIETY OF AUTOMOTIVE ENGINEERS, National Tractor Meeting & Production Forum. Hotel Schroeder, Milwaukee, Wis.

Sept. 13-25

FIRST INTERNATIONAL INSTRUMENT CONGRESS & EXPOSITION, Philadelphia, Pa. Technical sessions will run through this period, while the expositions will open on Wednesday the 15th. Eight technical societies are cooperating with the Instrument Society of America in arranging the meeting.

Sept. 28-Oct. 1

ASSOCIATION OF THE IRON AND STEEL ENGINEERS. Iron and Steel Exposition, Public Auditorium, Cleveland, Ohio.

Oct. 4-6

NATIONAL ELECTRONICS 10TH ANNUAL CONFERENCE, Hotel Sherman, Chicago, Ill.

Oct. 5-9

SOCIETY OF AUTOMOTIVE ENGINEERS, National Aeronautic Meeting, Aircraft Production Forum, and Aircraft Engineering Display. Hotel Statler, Los Angeles, Calif.

Oct. 6-7

INSTITUTE OF RADIO ENGINEERS, Professional Group on Nuclear Science. First Annual Conference, Sherman Hotel, Chicago, Ill. The theme of the conference will be Nuclear Reactor Technology, Particle Accelerators, and Nucleonic Instrumentation. A review of European Reactor Technology by noted scientists will be presented.

Oct. 11-15

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Fall General Meeting, Morrison Hotel, Chicago, Ill. Special emphasis will be on the electrical aspects of air transportation, with eight sessions planned on this subject. The Science and Electronics Div. plans sessions on computing devices, electronics, and nucleonics.

Oct. 18-20

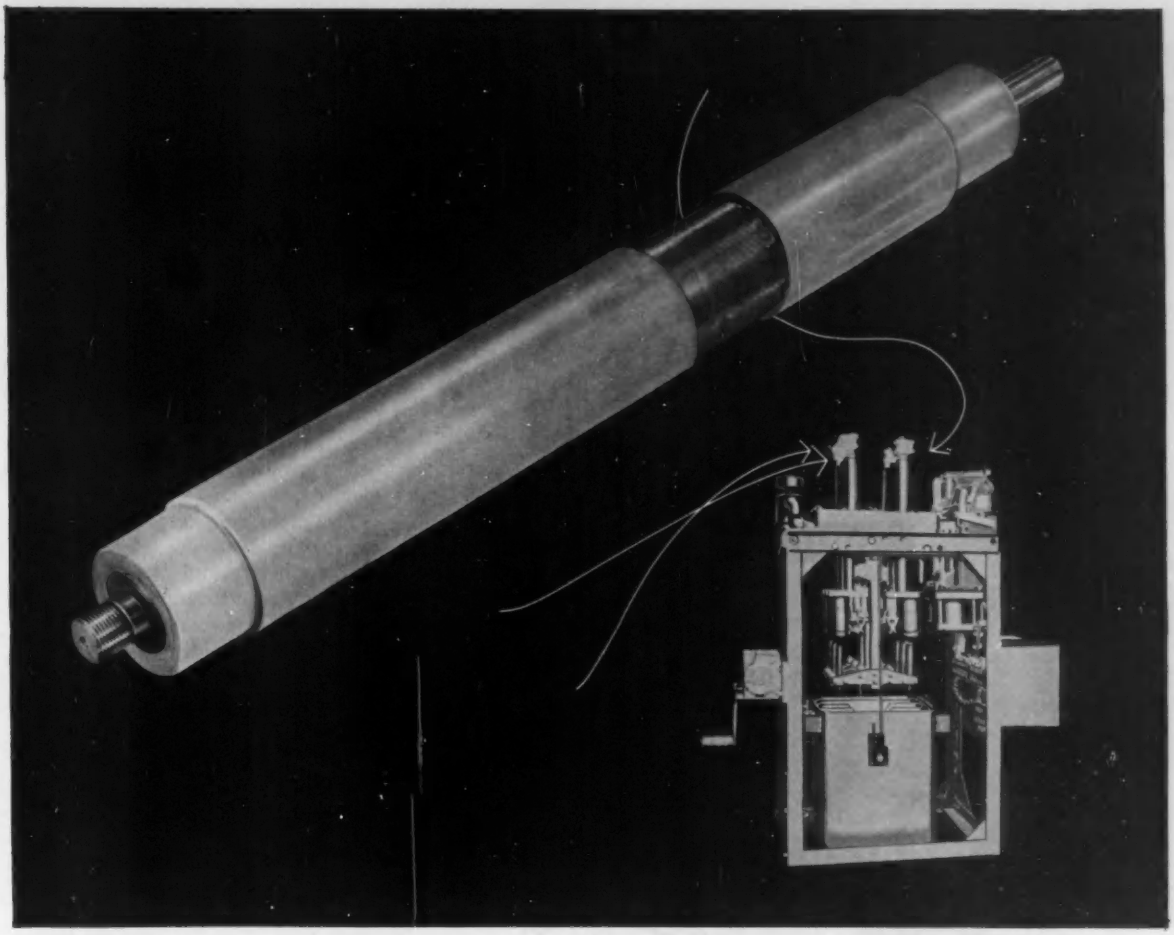
SOCIETY OF AUTOMOTIVE ENGINEERS. The National Transportation Meeting. The Sheraton-Plaza, Boston, Mass.

Oct. 25-27

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, The Machine Tool Conference, Hotel Statler, Detroit, Mich.

Nov. 1-5

AMERICAN SOCIETY FOR METALS. The National Metal Exposition & Congress, International Amphitheater, Chicago, Ill. Headquarters at the Palmer House.



# Where two materials are better than one

## Properties of Synthane

Among the outstanding properties of *Synthane* are:

**1. Mechanical strength.** Synthane exhibits excellent strength under tension, compression, impact, vibration and mild shock loads. It will not delaminate.

**2. Dielectric strength.** Synthane is widely used as an insulating material in many different applications.

**3. Low moisture absorption.** Most grades of Synthane are highly moisture resistant. Special grades are available for applications where absorption must be at a minimum.

**4. Dimensionally stable.** Synthane is a thermosetting plastic with a minimum cold flow. It holds its shape under normal conditions and at elevated temperatures.

**5. Availability.** In addition to more than 33 grades of sheets, Synthane is also supplied in many grades of rods and tubes. Molded-laminated and molded-macerated parts are also manufactured. A complete fabricating service is available.

This circuit breaker bushing is a most unusual application for *Synthane* laminated plastics combined with another material. Basically it's a conductor and an insulator—a solid copper bar—to which is bonded a thick insulating shield of *Synthane* laminated plastic.

There is one little joker in the design: each bushing contains a thin copper grid, only .003" thick, buried in the insulating plastic. It is positioned concentric to the copper core as the *Synthane* is being wound before curing. After curing, the bushing goes to our fabricating department. Here precision machinists turn off the *Synthane* over the grid until the delicate grid is fully exposed—yet unharmed.

*Synthane*—the material—was chosen for this job because of its combination of high dielectric strength, toughness and machinability. *Synthane*, the company, was selected because of its ability to handle a tough job. Our fabricating department is especially equipped to work with laminated plastics.

Look into the advantages of *Synthane* laminated plastics and *Synthane* fabricating service. Write for a free catalog detailing both. Synthane Corporation, 4 River Road, Oaks, Pennsylvania.

Our 25th Year

SYNTHANE CORPORATION, OAKS, PA.

SYNTHANE

LAMINATED S PLASTICS

CLEAN

BRIGHT

ACCURATE

STRONG

Clean, bright, accurate, strong — that's the story of Ritco Drop Forgings. We produce parts to your blueprint in steel or non-ferrous metals, in weights from ¼ lb. to 15 lbs.

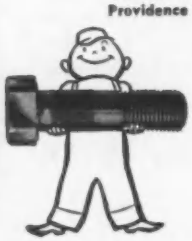
Come to Ritco for Drop Forgings, special fasteners, and finished bolts with regular or heavy heads. Also, take advantage of our complete facilities for finishing — machining and grinding. Send blueprints and specifications for free estimates.

1834 ★ 1954

SERVING AMERICAN INDUSTRY FOR 120 YEARS

RHODE ISLAND TOOL CO.
148 West River St.
Providence 1, R. I.

RITCO



Exclusive New England Representatives for Cleveland Cap Screw Co.

### Ad Libbing by the Editor

Years ago, before World War I, I heard this story concerning registration of brand names. The details are hazy but the basic idea and the principles involved are still clear in my mind.

The executive vice president of a concern in Germany manufacturing cigarettes was named Steengraf. The company was introducing a new brand of cigarettes and some one thought it would be a cute idea to reverse the syllables in Steengraf and call this new brand Graf Steen cigarettes, "graf" being the German word for the nobility title "count." So they made application for registration of the brand name "Graf Steen."

Back from the government registration bureau came a long, meticulously detailed form with the request that it be filled out completely and signed by Count Steen, with the signature to be notarized, or at least sworn to. The cigarette company returned the form, unsigned, with the explanation that the derivation of the brand name Graf Steen was simply Steengraf in reverse. Back from the bureau came the reply that it makes no difference, the tobacco company must find Count Steen or Graf Steen and have him sign the form.

"But there is no Graf Steen!" exclaimed the cigarette manufacturer. "We have looked all through Baedecker's listing of nobility, have searched all libraries and there is no Graf Steen!"

Replied the bureau boys, "Merely because you did not find a Graf Steen does not prove there is no Graf Steen. Perhaps it merely proves that you did not look hard enough or not in the right place. We cannot allow you to use the brand name Graf Steen until you find the gentleman and induce him to sign the form."

Graf Steen cigarettes never reached the market.

It is a true story, interesting and instructive. Just because one does not

know about it does not mean the thing is non-existent. And conversely, merely because a thing exists does not necessarily mean that people know about it. It is only too easy to keep secret those things that you want everybody to know about.

### Pernicious Secrecy

It was in the early twenties that I visited a foundry in the Lehigh Valley. Among other things, this foundry made cast iron trolley car wheels. All or most cast iron wheels that ride on rails have a chilled tread to minimize rim wear. I wanted to take a few students to visit that foundry because it would give them the chance to see the chills and how they are placed in the mould. I also expected that the foundry would have some sectioned wheel-rims that showed the depth of chill.

"Sorry," said the manager when I spoke to him. "We don't show anybody how we make these trolley car wheels. It is our secret. We make the best cast iron trolley car wheels that are made and we are not going to let any one see how we make 'em."

At that time I was spending my summers at the Berwick plant of the American Car and Foundry where they had a big foundry making cast iron freight car wheels, and no secrets either. So I said to the manager:

"Now that is interesting. You know, I have seen them making cast iron freight car wheels at the Berwick Plant of the American Car and Foundry Company. They make the best freight car wheels, just as you make the best trolley car wheels. But of course freight car wheels are heavier and harder to make, but they make the best. Go up there some time and tell my friend W. S. Johnson, the general manager, that I sent you. He will be glad to show you the foundry and tell you how they make the best wheels. They are so proud of the job they are doing that they couldn't possibly keep it a secret."

The Lehigh Valley outfit never did amount to anything and finally just shriveled up and disappeared. I think it was blown away, just like the Hoosier schoolmaster.

Secrecy is the greatest stumbling block in the path of progress. A company that depends on secret processes to retain its competitive position soon gets into a deep rut with a dam at each end, usually called a grave.—G.F.N.

*Mr. L. M. Puster* of our engineering staff, specialist in bellows applications.

● Whatever your problems on bellows assemblies, this specialist can give you answers that will save you time, trouble and money.

He'll know the advantages of metals to be considered for your application—brass, stainless steel, monel or nickel. He'll know the type of end fittings you should use. He'll recommend the correct bellows charge—volatile liquid or gas. And he'll give you the right advice on many other factors that will help make your bellows design plans more efficient.

Sylphon and Bridgeport bellows assemblies are used in many ways—for thermostatic devices, pressure controls, hydraulic mechanisms, expansion joints, as flexible connectors and in more applications.

Find out how our engineers can help you—and count up the savings our half-century of experience and ample production facilities can make for you. Write for full information.

**SEND FOR FREE BULLETIN**

*An idea-filled bulletin about metal bellows and bellows assemblies is yours for the asking. Send for free copy. Ask for Catalog PP-1400.*

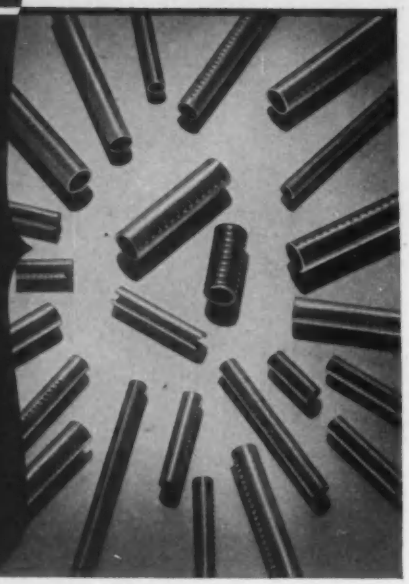
Robertshaw-Fulton
CONTROLS COMPANY

FULTON SYLPHON DIVISION
KNOXVILLE 1, TENNESSEE

BRIDGEPORT THERMOSTAT DIVISION
BRIDGEPORT 1, CONNECTICUT

# RESINITE EMBOSSED COIL FORMS

*...can increase efficiency of your iron core insertion production by 20%*



Special embossed construction eliminates torque control problems and stripping . . . prevents breakage or freezing of cores due to cross threading or improper starts.

Custom fabrication to your exact specification assures correct dimensions to within the most critical tolerances, plus uniformity throughout.

Threads are positioned in accordance with your requirement —full thread, each end, one end, center only.

We will furnish—without charge—a pilot production run of custom-made embossed forms to fit your particular application. We will also send a winding mandrel made to the specifications you supply.

Contact us now for full details about this special offer. Request technical bulletin, *Use of Threaded Tubes, Threaded Iron Cores VS. Torque Control.*

RESINITE CORPORATION

*Sales Representatives in:*

New England:
Framingham, Massachusetts, Framingham 7091

Metropolitan New York, New Jersey:
Jersey City, New Jersey, Journal Square 4-3574

Upstate New York:
Syracuse, New York, Syracuse 76-8056

Northern Ohio, Western Pennsylvania:
Cleveland, Ohio, Atlantic 1-1060

Indiana, Southern Ohio:
Logansport, Indiana, Logansport 2555

Missouri, Southern Illinois, Iowa:
St. Louis, Missouri, Sterling 2318

Maryland:
Baltimore, Maryland, Plaza 2-3211

Philadelphia, Camden:
Philadelphia, Pa., Chestnut Hill 8-0282

California:
Pasadena, California, Sycamore 8-3919

Canada:
Montreal, Quebec, Canada, Walnut 2715

Division of.. PRECISION PAPER TUBE COMPANY

2035K W. CHARLESTON ST. • CHICAGO 47, ILLINOIS


# ENGINEERING ABSTRACTS

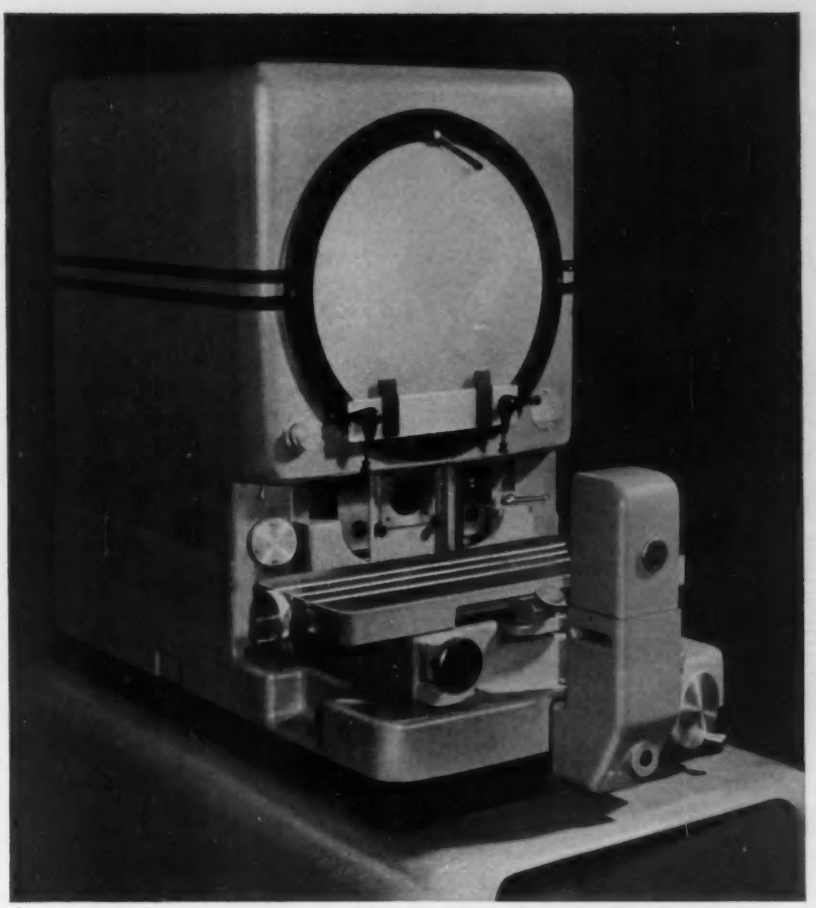
## PVC and Polyethylene

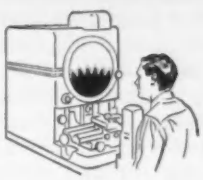
**Abstracted from "Flexible Materials—Extrusion and Molding Developments," by Frank A. Martin, Hoover Company, North Canton, Ohio, before the SPI Annual Conference, June 8, 1954, held in conjunction with the Sixth National Plastics Exposition, Cleveland, Ohio.**

THE TERM "FLEXIBLE PLASTICS" is often applied to plasticized compounds of polyvinyl chloride and its copolymers, and polyethylene. The properties of PVC and polyethylene are too well-known to require more than a brief enumeration. Both are thermoplastic in nature and thus require no vulcanization. PVC may be compounded to give a wide range of physical properties. Polyethylene has inherently good low temperature properties, and PVC may be compounded to have reasonably good properties at low temperatures. Both materials are unsuitable for use at high temperatures.

### PVC Compounding

Before PVC resin is useful for either molding or extrusion, it must be compounded with other materials. Plasticizers are added to make it flexible, stabilizers to protect it from the deteriorating effects of heat and light, fillers to improve processibility and lower costs, and lubricants to aid processing. The finished compound can be in one of two basic physical forms. If the compounding is done on a mixing mill or in a Banbury mixer and sufficient heat is applied to flux or melt the resin, then the compound must be chopped or pelletized, and it ends up in a granular form. This was the earliest approach to the PVC compounding problem. If, however, the various ingredients of a PVC compound are mixed in such a way that only sufficient heat is added to cause the resin to absorb the liquid components without actual fluxing of the resin, then the resultant compound ends up as a dry, free-flowing powder, commonly referred to as a dry-blend. This latter type of compounding has attracted widespread interest in the past several years for a variety of reasons. Equipment costs for dry-blending are lower than for making





## For maximum versatility in production inspection...

## the NEW KODAK CONTOUR PROJECTOR, Model 4

You'll find setups are faster, fixturing easier when you use the Kodak Contour Projector, Model 4, for routine gaging of precision parts.

Designed for use on the inspection line, it has a movable table with 4 inches of travel in both horizontal and vertical directions. This lets you handle a wide variety of parts with simple fixturing.

The Kodak Contour Projector, Model 4, has the same unique optical system as the famous Kodak Contour Projectors, Models 2A and 3. The 14-inch viewing screen covers a field of 1.4″ at 10× magnification. Vertical illuminator, surface illumination, six-power lens turret, and rotating screen with protractor ring are available as accessories. For complete details, write to:

**EASTMAN KODAK COMPANY**
**Special Products Sales Division**
**Rochester 4, N.Y.**

## the KODAK CONTOUR PROJECTOR

Kodak

**KUHN & JACOB**

is proud to be the molder of this attractive housing for the . . .

*Granco* UHF CONVERTER

**The "new look" acquired by this tried-tested-proven UHF Converter is largely due to the beautiful job of custom Bakelite molding done for Granco Products, Inc. of Long Island City by KUHN & JACOB MOLDING & TOOL COMPANY. The housing comes out of the 2-cavity die practically complete, with the exception of minor finishing operations.**

**Not only do we do the molding in such cases, but we make the molds as well. In fact we can place at your disposal complete facilities, from design to finished piece. Our operations are economical, too. Just write us a description of what you have in mind. We'll be glad to help you in any way we can.**

**KUHN & JACOB MOLDING & TOOL CO.**

**1204 SOUTHARD STREET, TRENTON 8, N. J.**

**CONTACT THE K & J REPRESENTATIVE NEAREST YOU**

S. C. Ullman, 55 W. 42nd St., New York, N. Y.
Telephone—Penn. 6-0346
Wm. T. Wyler, Box 126, Stratford, Conn.
Telephone—Bridgeport 7-4293
Wm. A. Chalverus, Carson Road, Princeton, N. J.




granular compounds, as are the mixing costs. Also the lower processing temperatures for dry-blending result in better heat stability for subsequent processing.

### PVC Molding

PVC compounds are usually molded by the injection process. Good moldings can be obtained on any of the common injection machines using either granular or dry-blend compounds, if certain fundamental principles are observed. First, the heating cylinder temperatures necessary for plasticizing vinyl compounds approach the decomposition temperatures. Secondly, PVC compounds have a lower heat transfer coefficient than most other thermoplastics. The powder mixes, incidentally, have a lower heat transfer rate than do granular compounds.

The basic problem in molding flexible PVC compounds becomes that of getting sufficient heat into the material to render it moldable without overheating to the point where decomposition sets in. Heating chamber temperatures of 350 to 375 F are commonly used, and at such temperatures, if the material is not allowed to stand, the danger of decomposition is relatively small. The plasticizing action is not generally a uniform one, since heat is applied principally to only one side of the material thickness. Further plasticizing action can be, and frequently is, obtained by making use of the principle that frictional heat is generated when the material is forced through a restricted passage. Therefore, the judicious selection of nozzle and gate sizes can add very materially to the overall plasticizing action.

Since cylinder temperatures must be held down and coefficient of heat transfer is low, the net result is lowered capacity of the machine. Some machines must be de-rated 50 per cent in comparison with their capacity to mold other thermoplastics.

Industry-wide experience has shown that the screw type extruder does an excellent job of plasticizing flexible vinyl compounds. The principle of pre-plasticizing can, therefore, be applied to the injection molding of PVC. Screw pre-plasticizing has been found to offer a number of advantages: (a) more thorough, uniform plasticizing action, resulting in better surface finish and gloss; (b) plasticization at lower machine temperatures as a result of the

frictional heat, which means less danger of material decomposition; (c) greatly increased plasticizing capacity resulting in more cycles per hour. Still another advantage of screw pre-plasticizing is that the gate size is no longer critical since it is no longer used to accomplish part of the plasticizing action. A further point in favor of screw pre-plasticizing is that the compounding action of the screw is ideally suited to the molding of dry-blends.

### Extrusion of PVC

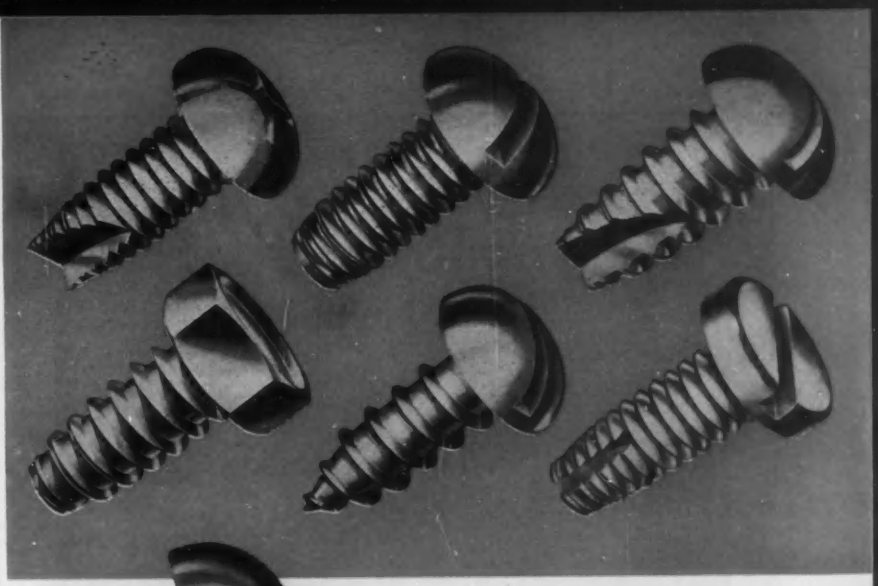
The art of extrusion is much more highly developed than is the molding of flexible PVC. Here again, the compound can be either in granular or dry-blend form. The extruders are essentially the same for either type of compound. They can be either oil or electrically heated. If electrical heat is used, some provision for carrying away the excess frictional heat is desirable. This may be accomplished by water jackets or by forced air.

For extrusion of dry blends, a screw length of 15 to 25 times the diameter is recommended. A compression ratio of 1.5 or 2 to 1 is satisfactory for granules, but for dry blends, the compression ratio of 3.5 or more is necessary.

The lower heat transfer rate of the dry blends in comparison to granular compounds also affects the extrusion conditions required. With a granular feed the extruder zone temperatures will generally run from approximately 300 F at the feed end, to 350 F at the end of the screw, with 350-360 F die temperatures. Dry blends require somewhat higher temperatures which may range up to 400 F along the barrel, with die temperatures about the same as for granules.

Flexible PVC materials have found a wide variety of extrusion outlets. Wire coating with PVC accounts for a large portion of the total PVC usage. Refrigerator door gaskets and channel strips for storm sash are widely extruded from PVC. Flexible PVC tubing in a variety of sizes and compounds has found wide use in such applications as laboratory tubing, beer tubing, plasma tubing and aircraft wiring ducts.

The ease with which flexible PVC compound can be extruded without a subsequent vulcanization as is necessary with rubber makes PVC a formidable competitor with rubber for applications

**You Get Economical, Quick, Secure Fastening with Townsend Tapping Screws**

You enjoy the economy of quality when you use Townsend tapping screws. They are made to provide an easy method of securely fastening metal, plastics, wood, asbestos and compositions with efficiency.

The use of Townsend thread forming screws eliminates costly tapping operations as the precision-rolled thread forms a mating thread when the screw is driven into the material. They are widely used in sheet metal, castings, and a variety of non-metallic materials. They may be removed and replaced without impairment of their holding power.

Townsend thread cutting screws have an off-center slot which presents a true, sharp, thread-cutting face which acts as a tap when the screw is driven into an untapped hole. By cutting their own threads, these screws fit tightly and resist loosening from vibration. There is no chance of size discrepancy between screw and tapped hole.

Townsend tapping screws are available in the types shown here in a variety of head styles with slotted or Phillips recessed and hex heads. They are but one group of the Townsend family of 10,000 types of standard and special fasteners and small parts used by all industry to improve assembly and speed production.

As representatives of "The Fastening Authority" Townsend engineers can draw upon 138 years of accumulated experience in wire drawing and cold forming to help solve your fastening problems. You can depend upon Townsend to give you excellent service in any quantity. For additional information on the economy of using Townsend tapping screws, send the coupon below or write.

**Townsend**
COMPANY • ESTABLISHED 1816
NEW BRIGHTON, PENNSYLVANIA
Sales Offices in Principal Cities
Cherry Rivet Division • Santa Ana, California

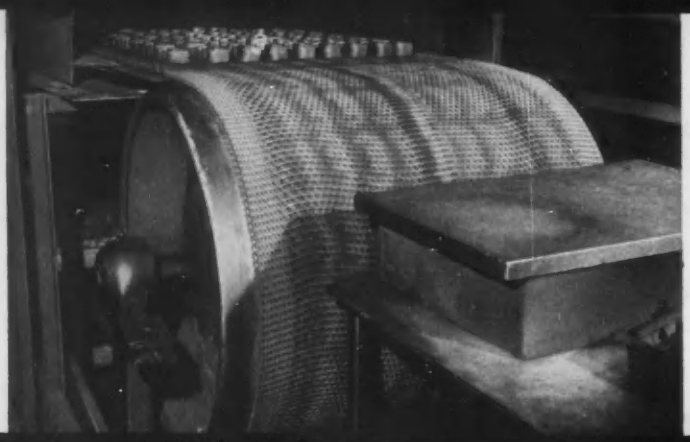
**In Canada:** *Parmenter & Bulloch Manufacturing Company, Ltd., Gananoque, Ontario*

**TOWNSEND COMPANY**
Sales Department
New Brighton, Pa.

Please send to me without obligation Tapping Screw Bulletin TL-88.

Name _____ Title _____
Company _____
Street _____
City _____ Zone _____ State _____

idea for AUTOMATION

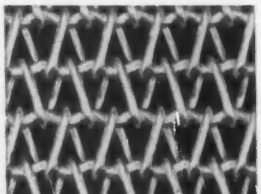


with CAMBRIDGE
Woven Wire Conveyor Belts

CONTINUOUS BRAZING

Metal products can be heat treated, quenched and cooled in one continuous series of operations on Cambridge belts. All-metal belt is unharmed by temperature, quench oils or sharp-edged, heavy loads. Working in process temperatures from sub-zero to as high as 2100° F. . . . and in dry or highly corrosive conditions . . . you'll find Cambridge Woven Wire Conveyor Belts help provide cost-cutting, automatic production by allowing you to process the work *continuously*. No batch operations, less manual handling in processing metal, food, chemical or ceramic products.

**OPEN MESH CONSTRUCTION** of belt provides free circulation of process atmospheres for uniform treatment, free drainage of process solutions. Of course, the all-metal construction means lowest maintenance cost.



**CAMBRIDGE BELTS** are available in any metal or alloy. Thus, the belt recommended for you can be fabricated from the specific material that will give longest belt life under your operating conditions. In addition, Cambridge belts can be woven to any length or width and in a wide variety of weaves and mesh sizes to meet your needs.

**FREE REFERENCE MANUAL gives full details on how Cambridge belts can boost output, cut costs by providing continuous, automatic production . . . *automation!* Includes all specifications and details, also metallurgical tables. Write for your copy today! Or, for specific recommendations, call in your Cambridge Field Engineer. He's listed under "Belting-Mechanical" in your classified 'phone book.**

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department P
Cambridge 8, Maryland

OFFICES IN LEADING INDUSTRIAL AREAS



where vinyl properties permit its use.

Whereas the rubber industry is vitally interested in the manufacture and processing of PVC, fabrication of polyethylene has remained primarily in the hands of purely plastics processors. This may be accounted for by the fact that PVC and rubber are competing for the same end uses, while polyethylene, although it may be construed as a flexible plastic, is not so directly competitive with rubber.

Polyethylene is easy to mold by the injection process. This material does not readily decompose at processing temperatures. The problems encountered in molding PVC are therefore non-existent. Perhaps the biggest problem in molding polyethylene is control of mold shrinkage. Shrinkage can be varied widely through control of material and mold temperatures, and of injection pressure.

The extrusion of polyethylene has largely been in three types of goods—piping, wire covering, and blown film. Polyethylene pipe has been very successful for jet wells and for carrying corrosive mine waters. Its light weight makes it easy to install, and its chemical resistance practically eliminates maintenance problems. Twenty million pounds of polyethylene were used for pipe in 1953.

Polyethylene's excellent dielectric properties, good aging, and low water absorption have combined to bring it to prominence in the insulated wire and cable field. Its dielectric strength at high frequencies makes it better than rubber for such applications, while the low moisture absorption renders it outstanding for submarine cable jacketing.

## Rigid and Rubber-Modified PVC

**Abstracted from "Rigid Vinyls and Rubber-Resin Blends—Processing and Applications," an address delivered by George S. Laaff, Bolta Products, Div. of General Tire & Rubber Co., Lawrence, Mass., before the SPI Annual Conference at the Hotel Cleveland, June 8, 1954, held in conjunction with the Sixth National Plastics Exposition at the Public Auditorium, Cleveland, Ohio, June 7-10, 1954.**

PRIOR TO 1950, rigid vinyl, generally acknowledged as a vinyl chloride acetate copolymer compound, had gained wide acceptance for many consumer and industrial applications.

In 1950 the first domestic unplasti-

cized polyvinyl chloride resin compounds in the form of sheets, pipes, tubes and rods were offered to industry as a new tool in the fight against corrosion.

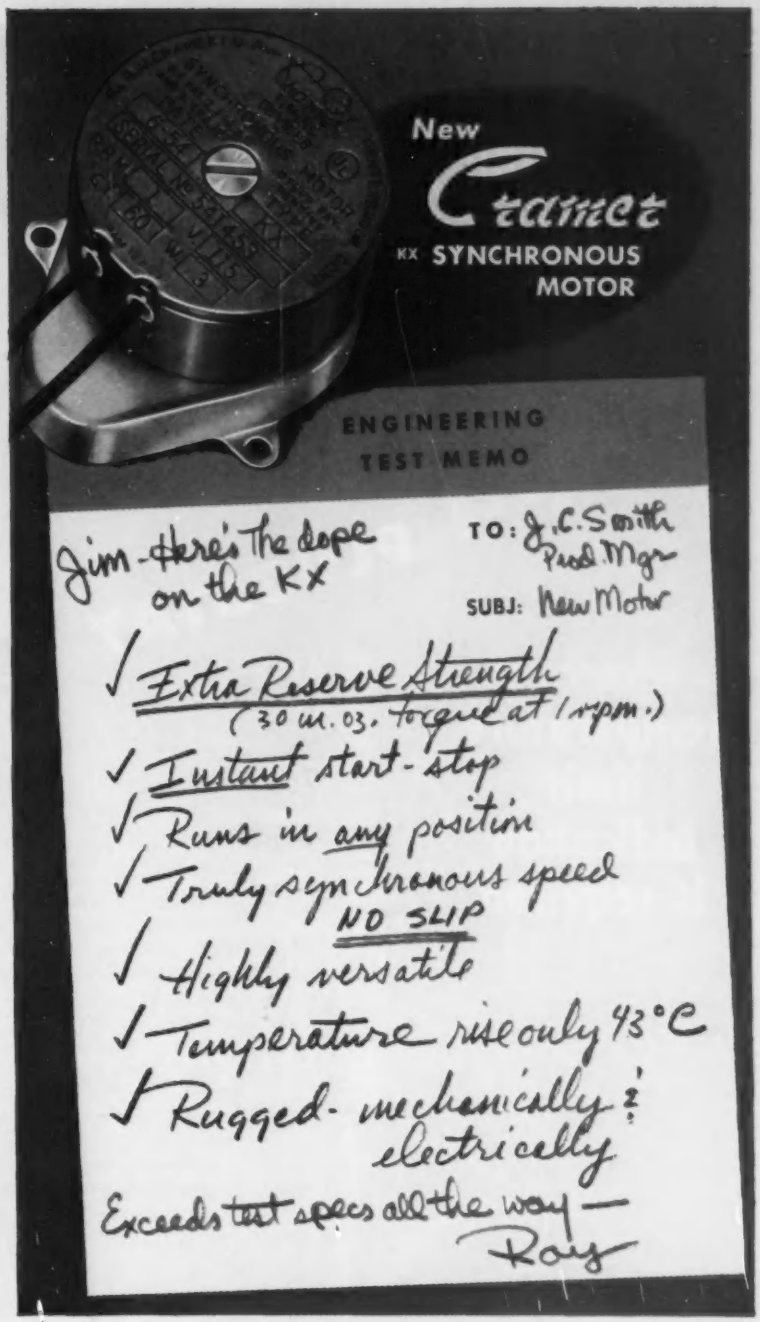
The term "unplasticized" PVC is used when referring to a compound of substantially pure polyvinyl chloride resin in which only the minimum amount of stabilizer for processing and service life is used.

Unfortunately, the establishment of unplasticized PVC as a prime material for corrosion resistant service has encountered considerable opposition due to its basic lack of toughness. The Germans have proved a basic concept that polyvinyl chloride, when used as a corrosion resistant material, must be modified as little as possible. Only through the use of unadulterated materials can the inherent chemical resistance capabilities be realized, and full possibilities for the welding of extruded, molded or sheet parts be achieved.

One means of imparting improved toughness to PVC has been the incorporation of rubber blends. Rubber modified compounds have been successfully produced by direct addition of premasticated Buna-N rubber to fluxed vinyl in a Banbury mixer or by the co-precipitation of blended latices. The product derived from co-precipitation can be dried and reduced to fine resin particles. As with all vinyl resins, it must then be formulated with stabilizers, colorants and lubricants.

Twin screw extruders are believed to produce the greatest quantity of unplasticized and modified PVC pipe and tubing in the world today. However, the single screw extruder is being designed to extrude all thermoplastics from granules or powder at rates once considered "fantastic." Foremost among the requirements recognized as the basis of new designs is the utilization and necessary control of frictional heat. The extruder of the future will have great power, short and long screws, single or multiple mixing stations at the front, center or rear and it will deliver a variety of completely fluxed materials at a rate of over 500 lb per hour. Temperatures will be controlled ±0.5 F, by means of high velocity recirculating fluids and the bottleneck of sizing and takeup systems will be broken.

High molecular weight emulsion polymerized resins have been found to



New
Cramer
KX SYNCHRONOUS MOTOR
ENGINEERING TEST MEMO
Jim - here's the dope on the KX
TO: J. C. Smith Prod. Mgr.
SUBJ: New Motor
✓ Extra Reserve Strength (30 in. oz. torque at 1 rpm.)
✓ Instant start - stop
✓ Runs in any position
✓ Truly synchronous speed NO SLIP
✓ Highly versatile
✓ Temperature rise only 43°C
✓ Rugged - mechanically & electrically
Exceeds test specs all the way —
Ray

**This does not tell the whole story by any means, but it does indicate the growing acceptance of this powerful motor for all types of instrument and control applications which require constant speed and dependability even under adverse environmental conditions. The complete story is yours for the asking. Write today.**

Cramer TIMING DEVICES

SPECIALISTS IN TIME CONTROL

the R. W. CRAMER CO., Inc.

BOX 7, CENTERBROOK, CONNECTICUT

10CR54

...thermal sensing unit

C·P·I PLUGSTAT®

—wherever temperature limit indication is required

CPI PLUGSTATS provide precise thermal warning without calibration drift. Small physical size has been combined with rugged construction. Special alloy contacts assure clean make-and-break. Capable of 200°F overshoot from high or low normal setting. Available also with AN connector. Rated at ¼ ampere, 28 volts, AC or DC resistive loads. Contacts NO or NC. Weight approx. 1.5 oz.

Proven dependable in —
AIRCRAFT GENERATORS
AIR COOLED ENGINES
WATER COOLED ENGINES
TRUCK REAR ENDS
MARINE ENGINES
BEARINGS
PIPED LIQUIDS
GEAR BOXES

CONTROL PRODUCTS INC

318 SUSSEX STREET
HARRISON, NEW JERSEY



extrude with great ease and with a mirror finish both inside and out. The heat welding values, however, are low. Many extruders learned from costly experience that three commercially available resins will give three pipe sizes—over, under and die size. Formulation changes often entailed retooling. Every extrusion die blueprint was submitted to the tool shop with apprehension because any change in resin or compound formulation would change the end dimension. Now, molecular weight and molecular weight distribution are being studied to ascertain their effect on melt-down viscosity in relation to physical properties and appearance. The polymer chemist has thus been stimulated to work with the extrusion engineer to determine the merits of various polymerization techniques and improve on uniformity. For example, control of the specific viscosity to the third figure has been found necessary to insure optimum bonding strength of laminated unplasticized PVC sheets and insure uniform extrusion behavior of large diameter pipe, tubes and rods. Modified PVC is less critical in this regard.

Conversion and fabricating equipment include deck and continuous laminating presses, injection, extrusion and ring and plug molding, as well as vacuum molding.

As with unplasticized PVC, the method of fabrication offering the widest range of applications for modified PVC and extending the possible size of installations almost infinitely, is that of hot gas welding. Much of the art of early hot gas welding has now been resolved into widely accepted concepts. The present day hot gas welding torch consists of a coiled tube, heated by a gas flame or resistance coil, through which passes the welding gas, usually compressed air or an inert gas such as nitrogen or carbon dioxide. By varying the size of the flame or the velocity of the gas, the temperature of the issuing hot gases may be varied over a wide range. For welding modified PVC, temperatures of 500 to 575 F are normally used. This optimum gas temperature would appear to be 20 to 25 F above that used for unmodified PVC.

An automatic welding machine has lately been developed and production tested—welding at the rate of over 30 in. per min as compared to hand welding of 10 to 12 in. per minute. This

machine welds faster, more uniformly, strainfree and the welding values are higher.

The addition of modifying rubber seems to cause a slight reduction in the weldability of unplasticized polyvinyl chloride, thus creating a problem in the production of a welding rod able to withstand impact. A welded joint of high impact sheets inevitably lacks the impact of the sheets themselves. Where an unplasticized PVC weld might have an impact strength superior to the sheets used, a similar weld of a PVC-rubber blend is consistently the weakest point.

In conjunction with extruded pipe many types of fittings are available. There are both transfer and injection molded fittings as well as fabricated fittings. Most joints now in use are of the threaded, molded or cemented variety. By making use of the rheological properties of PVC, a newer type of fitting is available—a shrink coupling shrink fitting—which may be used alone or supplemented with cement or welding. A molded fitting is pre-stressed to a dimension greater than normal. By inserting the ends of pipes to be connected, and relieving the strained section of the fitting by the gentle application of heat, a tight bond is formed by the resultant shrinkage. Caution must be used in the heating of the fitting. It is imperative to heat the fitting slowly through its entire thickness to avoid surface cracking.

Modified polyvinyl chloride may be shaped by slight modifications of the common forming techniques used in the plastic industry. Shallow forming may be effected on thin sheets by the vacuum method. The molds may be made inexpensively of wood, masonite or aluminum. A vacuum of 17-25 in. of mercury is sufficient to mold sheets up to $\frac{1}{8}$ in. thickness. The material is heated in an oven and is then quickly placed on the mold. A sealing frame is lowered, and the vacuum is applied and maintained until the stock cools somewhat, and then the molded piece is removed. After complete cooling the piece is trimmed on a saw, router or shear.

When moldings are made of thicker materials or where deeper draws or sharp curves are required, the "Plug and Ring" mold may be used. The sheet, heated as in vacuum molding, is placed in the mold. The forming plug is lowered until the pressure ring


by Design

BIJUR

AUTOMATICALLY ASSURES CUSTOMER SATISFACTION

the user of your machines

- Increases Productive Capacity
- Saves on Repair Bills
- Eliminates Costly Hand Oiling
- Reduces Downtime
- Lengthens Machine Life

WITH Bijur Automatic Lubrication as an integral part of your equipment, your customers benefit from continuous peak production. Plant after plant reports increased out-put and greatly reduced maintenance costs with Bijur-equipped machines. Costly downtime for lubricating by hand is eliminated. Every bearing is metered the proper quantity of oil at predetermined intervals. Work spoilage and bearing troubles caused by over-lubrication are avoided. Fire hazards are reduced. Personnel accidents are prevented.

Bijur gives you the opportunity to add customer satisfaction through improved machine performance.

More than a million Bijur-protected machines are in use. Hundreds of leading manufacturers standardize on Bijur as "built-in" components of their machines. Bijur emphasizes custom-engineering, and we will gladly cooperate in designing a system to meet the specific requirements of your machine.

Design Bijur into your machines now in production or in the planning stage. Write for literature and engineering information.

0-2

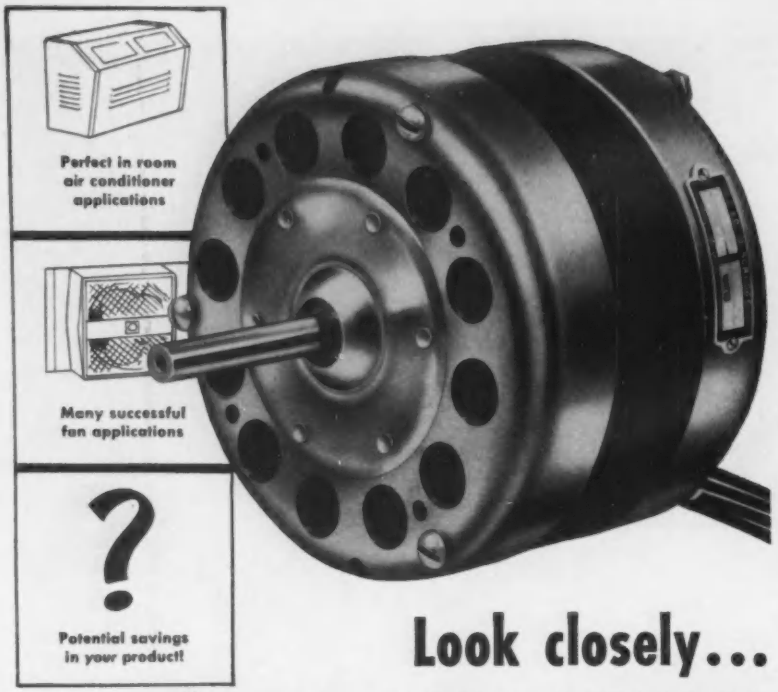
2369

BIJUR

LUBRICATING CORPORATION

Rochelle Park, New Jersey

*Pioneers in Automatic Lubrication*




# Look closely... this new LOYD SCRUGGS 6-pole shaded pole motor may be your answer!

This *new* motor is typical of Scruggs' fast-growing versatility in the fractional horsepower motor field.

The precision standards of Scruggs motors, proven in Dictaphones and many other famous products, are more rigid than ever. And new plant facilities now permit faster deliveries, wider scope and lower pricing.

Take advantage of this *custom-built* motor service at stock motor prices. Develop better products at lower cost!

**WE'LL SEND YOU a sample motor built to your specs. Write today for detailed Data and Performance Chart. Immediate service!**

**CHECK THESE QUALITY FEATURES:**

1. Copper-weld rotor for uniform performance
2. Long-life sintered bronze bearings
3. Extra large oil reservoirs
4. Extremely quiet running
5. Rotor electronically balanced
6. Double varnish impregnation
7. Design practically eliminates AC hum

*You can stake your reputation on Scruggs Motors*

THE Loyd Scruggs COMPANY

Festus, Mo.—A Dazey Corporation Subsidiary

MANUFACTURERS OF PRECISION INSTRUMENTS SINCE 1934




grips the sheet edges. The plug then continues downward pressing the sheet into the mold contour. Because of the pronounced "elastic memory," formed parts must be rigidly clamped in the forming jig until completely cooled.

As in the machining of unplasticized PVC, care should be taken to avoid sharp changes in cross section. Drilling or grooving in areas of critical stress must also be avoided. Parts should not be "forced fit" if there is an alternative. If proper consideration is given the design and shaping of machined parts, their service life will more than compensate for the time so spent.

## Flame-Plated Tungsten Carbide

**Abstracted from "Flame-Plating Tungsten Carbide," by M. A. Teter, Development Engr., Linde Air Products Co., New York, N. Y. Presented at the Tenth Annual Meeting of the Metal Powder Association, Chicago, Ill., April 1954.**

TUNGSTEN CARBIDE deposited by flame-plating on a wide variety of metals such as aluminum, magnesium, and titanium offers such properties as: (1) a combination of light weight, low inertia and wear-resistance, (2) relatively low modulus of elasticity, and (3) resistance to thermal and mechanical shock. Essentially, flame-plating is a method of applying tungsten carbide in thin layers, 0.002 in.—0.010 in. thick, to base metal with no detrimental base metal dilution or over-heating. Parts being plated seldom reach or exceed 400 F. Such a temperature has little or no effect on the base metal. Flame-plated tungsten carbide is not intended to replace solid carbide, but to supplement carbide and other wear resistant materials in many applications.

The material presently applied is 92 percent tungsten carbide and 8 percent cobalt. Because of the unique method of application, the material's micro structure is completely different from that of solid carbides, resulting in differences in physical properties and characteristics between the materials.

The hardness of the flame-plated coating ranges from 1,400 to 1,500 Vickers Pyramid Number, on application of a 300 gram load. This compares approximately to 89 Rockwell "A." Flame-plated tungsten carbide

**PERFORMANCE-WISE CERAMIC BUYERS ASK ABOUT**

# press facilities

**AlSiMag®**

Invariably this question is brought up by seasoned buyers. Experience has taught them that no amount of good intentions can compensate for inadequate production machinery. To such practical and fore-sighted men, the following facts are presented for consideration:

To meet customer requirements for quality tested AlSiMag ceramics, American Lava Corporation maintains lineups of modern high speed presses which can produce *in one three-shift working day over 9,000,000 uniform, accurate AlSiMag pieces* (more than enough, laid end to end, to reach from Philadelphia, Pa., to Washington, D. C.)*

Why risk dole delivery when you can command AlSiMag production facilities ready to serve you?

* Based on an AlSiMag part 1" square. Our presses can produce pieces up to 14" x 14" and, of course, much smaller parts than the size mentioned.

53RD YEAR OF CERAMIC LEADERSHIP

## AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY

OFFICES: METROPOLITAN AREA: 671 Broad St., Newark, N. J., Mitchell 2-8159 • SYRACUSE, N. Y., 647 S. Warren St., Phone 74-4889 and 74-4880 • CLEVELAND: 5012 Euclid Ave., Room 2007, Express 1-6685 • NEW ENGLAND: 1374 Mass. Ave., Cambridge, Mass., Kirkland 7-4498 • PHILADELPHIA: 1649 N. Broad St., Stevenson 4-2823 • ST. LOUIS: 1123 Washington Ave., Garfield 1-4959 • CHICAGO: 228 N. LaSalle St., Central 6-1721 • SOUTHWEST: John A. Green Co., 6815 Oriole Dr., Dallas 9, Dixon 9918 • LOS ANGELES: 5603 N. Huntington Dr., Capitol 1-9114 • SOUTH SAN FRANCISCO: 320 Shaw Rd., Plaza 6-0800 PITTSBURGH: 911 Plaza Bldg., Atlantic 1-2075

Give your customer more for his money

# SLOW DOWN WEAR

## with Carboloy® cemented carbides

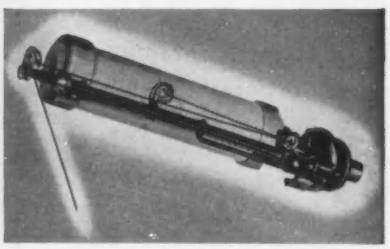
Wear is the common denominator of all equipment, reducing life, accuracy and greatly increasing costs.

To slow down wear, many product and machine designers are applying Carboloy cemented carbides. In most instances, wherever friction, corrosion, erosion or abrasion are met, Carboloy cemented carbides can increase durability *many times over.*

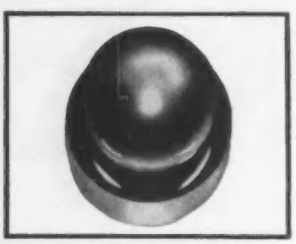
These three case histories are typical of many more which may suggest important wearproofing possibilities for your own machines and products.

Look over *your* products and call upon the Carboloy Engineering Appraisal Service for expert assistance. We will work with you in selecting and applying the cemented carbide that will best solve *your* wear problem. This service is free. Please write.

Power socket wrenches, equipped with carbide inserts, outlasted ordinary wrenches a minimum of 15 to 20 times; eliminated screw, product damage caused by wrench slippage; sharply cut socket replacement costs and production line downtime.



In textile mills, threads traveling at high speeds quickly cut through steel or porcelain guides. Carbide guide ring inserts, used to resist such wear, lasted 50 to 100 times longer. They also greatly reduced thread snagging and snapping, spoilage and downtime.



Subsurface pumps in oil wells use balls and seats of Carboloy cemented carbide to resist acids and abrasive sands found in crude oil. Carboloy balls and seats outlast steel 20 times; maintain sphericity under severest conditions of impact and pressures.

**Put These Outstanding Characteristics To Work In *Your* Plant:**

- High abrasion resistance
- High corrosion resistance
- High erosion resistance
- High heat resistance
- High impact strength
- Non-magnetic
- Light weight (where desired)

**CARBOLOY**
DEPARTMENT OF GENERAL ELECTRIC COMPANY
11127 E. 8 Mile Blvd., Detroit 32, Michigan

"Carboloy" is the trademark for products of the Carboloy Department of General Electric Company



has a relatively low modulus of elasticity, approximately 27 million as compared to 90 million for solid carbides, indicating good resistance to thermal and mechanical shock.

Thin tungsten carbide coatings, 0.002 in. or 0.003 in. thick, have a high degree of resistance to thermal shock. Thermal shock tests, for example, were conducted on steel flame-plated with a tungsten-carbide coating 0.002 in. thick. These specimens were subjected to a tension of approximately 15,000 psi, heated to 1,300 F, and cooled by an air blast in 30 sec to 100 F. The strips were subjected to over 1,000 cycles without failure.

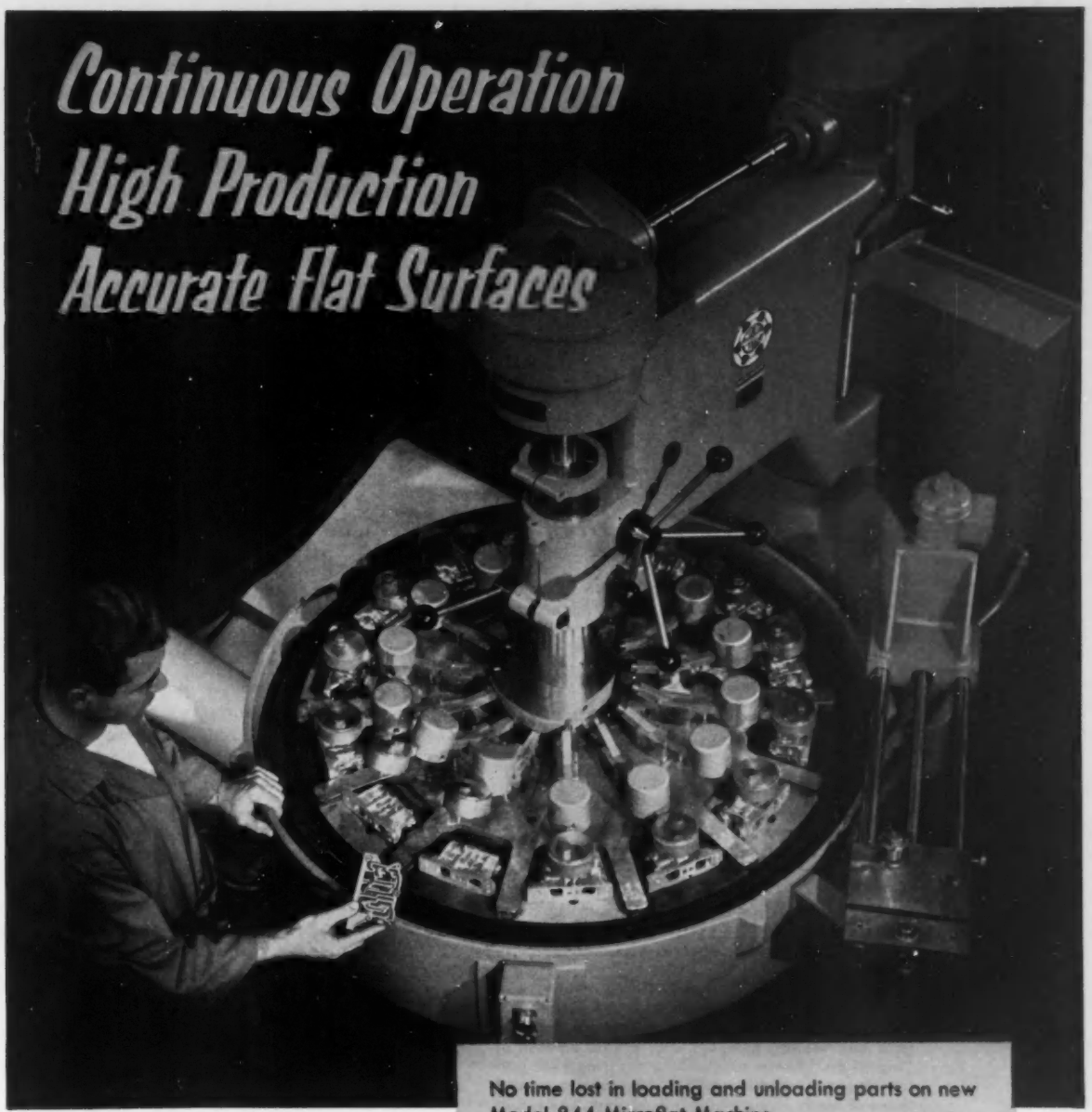
To date, there is not sufficient existing information on corrosion resistance of these materials. However, tests are under way and results should be available shortly. Presently, it may be considered that any medium capable of attacking cobalt will attack a flame-plated coating.

The thickness of a coating applied to parts is mainly dependent upon the type of service it will be subjected to and whether a finished surface is required. With close tolerance, high-precision parts, a finished coating thickness of 0.002 in. is recommended. To obtain a 1 to 5 micro in. (RMS) finish, it is necessary to remove 0.003 in. or 0.004 in. coating thickness. For example, a round gage or rod would be undercut 0.004 in. on the diameter, and a coating thickness of 0.010 in. on the diameter would be applied, leaving 0.006 in. on the diameter to be removed during finish grinding and lapping. Generally, thin coatings are more desirable than thick coatings because they are less expensive and are much more resistant to thermal and mechanical shock.

### Flame-Plated Bearings

Among the present applications of flame-plated tungsten carbide are bearing surfaces possessing excellent wear resistant characteristics, as well as relatively low coefficients of friction. It is believed that many bearing failures results from fusion of the fine surface particles caused by instantaneous high skin temperatures. This phenomenon is minimized with flame-plated bearing surfaces because of the high fusion temperature involved in their application, 5,100 F. and the relatively low coefficient of friction. Flame-plated surfaces mating with

# Continuous Operation
# High Production
# Accurate Flat Surfaces



No time lost in loading and unloading parts on new Model 844 Microflat Machine.

New type multiple-station, self-actuated fixture and more selective controls give this machine a production capacity of a finished part every 3 seconds.

For complete description of this new Microflat Machine write for CROSS-HATCH, Vol. 6, No. 1.

1929 • 1954 — PRECISION PRODUCTION THROUGH MICROHONING — MICRO MATIC — 25TH YEAR OF DEVELOPMENT

**MICROMATIC HONE CORPORATION**

**8100 SCHOOLCRAFT AVE., DETROIT 38, MICHIGAN**

MICROMATIC HONE CORP.
MICRO-MOLD MFG. DIV.
Boston Post Road
Guilford, Connecticut

MICROMATIC HONE CORP.
2205 Lee Street
Evanston, Illinois

MICROMATIC HONE CORP.
1535 Grande Vista Avenue
Los Angeles 23, California

MICROMATIC HONE LTD.
330 Grand River Avenue
Brantford, Ontario, Canada

MICROMATIC HONE CORP.
MICRO-MOLD MFG. DIV.
231 So. Pendleton Avenue
Pendleton, Indiana

*REPRESENTATIVES:* Allied Northwest Machine Tool Corp., 103 S.W. Front Ave., Portland 4, Oregon • Mason Machine Tool Company, 415 So. Second East, Salt Lake City, Utah
Tidewater Supply Co., Charlotte 4, North Carolina

REPRESENTATIVES IN ALL PRINCIPAL COUNTRIES

*SUBSIDIARY:*

***Micro-Precision Inc., 2205 Lee Street, Evanston, Illinois***

*Hydraulic Controls • Diesel fuel injection equipment*

**in Perkins custom-made Gears**

**We have manufactured precision gears to customers' specifications for over thirty years. This collective experience enables us to approach any gear engineering problem with a vast amount of "hindsight." For no matter how exacting your particular requirements may be, they cannot exceed those of many of our regular customers. The return of a buyer's market places a premium on quality. And if — in the product you manufacture, quality is synonymous with trouble-free power transmission — our gear engineering service will be of great value to you right now. Ask us for suggestions, ideas and cost estimates today.**

**PERKINS MAKES: helical gears, bevel gears, sprockets, ratchets, worm gears, spiral gears, spur gears with shaved or ground teeth, ground thread worms.**

NOTE: The PERKINS PRECISION SPRING COILER is the latest development in the spring coiler field and eliminates entirely the use of arbors and long set-up time. It is a complete self-sufficient machine and enables you to make the spring you want when you want it—in seconds. The coiler produces any type of spring, in any diameter and any pitch with this range: Wire sizes .005 to .125. Diameter, from 3/32" to 12" and larger. Size of the compact coiler is only 7½x16". A POWER MODEL mounted on a welded steel console base is also available. Full information on request.

**PERKINS Machine & Gear Co.**
**WEST SPRINGFIELD, MASSACHUSETTS**



solid carbide surfaces have proven to be excellent bearing combinations. Flame-plated bearings can incorporate precision fits, because both shaft and journal can be fabricated of a base material having the same coefficient of expansion. Past experience indicates that very little lubrication is required on flame-plated bearings.

Dimensional limitations on parts that can be flame-plated presently restrict wide application of flame-plated tungsten carbide. Diameters from 0.059 in. to approximately 9 in. can be plated with a maximum length of 30 inches. Flat areas can be plated approximately 9 in. wide by 40 in. long. Presently a weight of 150 lb per part is the maximum permissible. Internal diameters, $\frac{3}{8}$ in. minimum, can be plated to a depth equal to the ID. Blind holes, cavities, or very small grooves often present some difficulties. Sharp internal corners or external corners must be eliminated where possible.

The geometry of the part can also be a restricting factor in the use of flame-plated tungsten carbide, and the operating condition of the part must be considered. Parts operating at extremely high temperatures or subject to base metal deformation are not usually satisfactory flame-plating applications.

Despite the newness of flame-plated tungsten carbide, its possibilities warrant evaluation. By combining a base metal of aluminum, magnesium, and titanium with a flame-plated surface, light weight and low inertia can be combined with a hard wear-resistant surface. Parts made of these metals are presently being plated. Many other metals have been deposited experimentally, including aluminum, magnesium, copper, nickel, stainless, chrome carbides, dual and multi-carbides. Tungsten carbide, however, is the only coating being applied commercially at present by flame-plating.

Recently, several sintered bronze and sintered iron parts were coated with tungsten carbide. It would be possible to use these parts in the "as coated" condition or finished by grinding and lapping. Presently, there are no commercial applications of coated sintered parts; however, it is conceivable that parts could be produced economically, by powdered metallurgy with certain areas flame-plated with tungsten carbide.

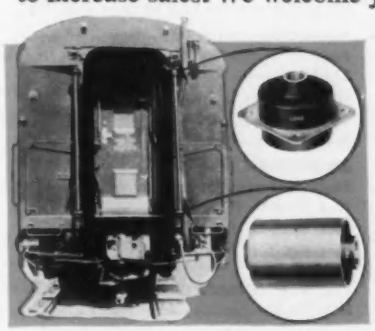
# JUST A MATTER OF CONTROL

## LORD ENGINEERING CONTROLS VIBRATION

### . . . anywhere!

To minimize the damaging effects of vibration and shock is . . . just a matter of control. Here at Lord the research engineer, chemist, metallurgist, designing engineer and craftsman work as a team to meet the conditions under which the use of Lord Vibration Control Mountings improves product performance. Our 30 years of technical "know-how" is concentrated on your vibration and shock control requirement . . . and Lord Precision Manufacture results in mountings and bonded-rubber parts which not only improve performance but also reduce the operating and maintenance costs of your product. This helps you to increase sales. We welcome your inquiries.

*Over 27,000 designs and their variations from which to choose.*



**Another instance where Lord Vibration Control Engineering profits end-product manufacturers. To stop the rattle of the between-car Diaphragm and permit free movement, Lord Plate Form Mountings are used at the top and Lord Tube Form Mountings at the bottom of each Diaphragm Support on modern passenger cars.**

**LOS ANGELES 28, CALIFORNIA** 7046 Hollywood Blvd.
**DALLAS, TEXAS** 313 Fidelity Union Life Building
**PHILADELPHIA 7, PENNSYLVANIA** 725 Widener Building
**DAYTON 2, OHIO** 410 West First Street
**DETROIT 2, MICHIGAN** 311 Curtis Building
**NEW YORK 16, NEW YORK** 280 Madison Avenue
**CHICAGO 11, ILLINOIS** 520 N. Michigan Ave.
**CLEVELAND 15, OHIO** 811 Hanna Building

**LORD MANUFACTURING COMPANY • ERIE, PA.**

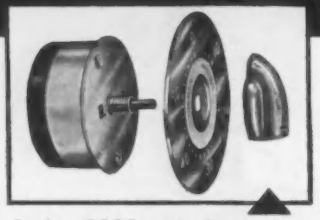
LORD BONDED RUBBER

*Headquarters for* **VIBRATION CONTROL** FOR 30 YEARS

**Mark-Time Timing Devices**

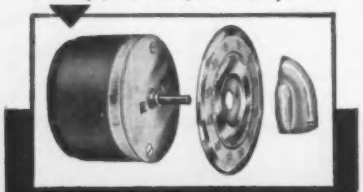
**OK'd for DAMP environments**

Specially adaptable for machines where dampness is present, with splash-proof housing and special water-repellent construction.



**Series 6200 — Breaks circuit at end of various intervals from 60 seconds to 5 hours. Designed for washing machines, dishwashers, sterilizers, etc. May be supplied with HOLD feature, for operation of wringers without timer. Electrical data: UL approved — 20-amp., 125 volt, 1 H.P. or 10-amp., 250 volt, A. C. only.**

**Series 6700-6800-6900 — Heavy duty, 2 circuit time switches, to break circuits either after different time intervals or simultaneously at end of same interval. 6700 Series for dishwashers, hair driers, etc.; 6800 Series primarily for battery chargers; 6900 Series for heavy duty circuits in clothes driers. Time periods range from 60 seconds to 5 hours. Electrical data: UL approved — 6700 and 6800, 20-amp., 125 volt, 1 H.P. or 10-amp., 250 volt, A. C. only; 6900, 28-amp., 250 volt, A. C. only.**



Write today for catalog sheets specifying intended application. Rhodes engineers and designers will be glad to work with you on special applications. There's no obligation.

**M. H. RHODES, INC.**
**HARTFORD 6, CONN.**

MARK-TIME

Manufactured and sold in Canada by SPERRY GYROSCOPE OTTAWA, Limited 3 Hamilton St., Ottawa, Ontario, Canada


# NEW BOOKS

## Letter Symbols For Acoustics

*Prepared by Sectional Committee on Letter Symbols. Booklet, paper-bound, 11 pp. Published by The American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y., $1.*

Signal and communications engineers, theater operators, radio and television technicians and manufacturers, and other persons engaged in work involving acoustical measurements will find this booklet of practical value.

This new American standard lists more than one hundred symbols for terms used in acoustics measurement. Preparation of the standard was begun in 1949 by a group under the chairmanship of Harry F. Olson, RCA Laboratories, Princeton, N. J. The group operates under the Sectional Committee on Letter Symbols, chairman of which is H. J. Turner, associate professor of electrical engineering at Yale University.

Established in 1926, the committee has now produced a total of 13 standards in letter symbols, for mathematics, hydraulics, mechanics, structural analysis, heat and thermodynamics, illuminating engineering, aeronautical sciences, electrical quantities, radio, physics, chemical engineering, meteorology, and acoustics.

## Acoustics

LEO L. BERANEK, *Associate Professor of Communication Engineering, MIT. 6 x 9 in., 481 pp. Published by the McGraw-Hill Book Co., 330 West 42 St., New York 36, N. Y., $9.*

Designed for the engineer or scientist who intends to practice modern acoustics in the laboratory or in the field, this new text presents a comprehensive study of the entire subject. Included are recent advances in such topics as dynamical analogies, directivity patterns, acoustical circuits, loudspeaker enclosures, sound transmission through structures, noise reduction, speed communication and psychoacoustic criteria.

Less mathematical than many texts, this volume develops logically the the-


**ANALOG COMPUTER and SIMULATION FACILITIES now available**

**NATIONAL NETWORK OF *EASE** COMPUTER FACILITIES OFFERS IMPORTANT BENEFITS**

EASE* = ELECTRONIC ANALOG SIMULATING EQUIPMENT

Now available for consultation and hire are competently-staffed independent organizations fully-equipped with EASE computers and linked in a network to provide full interchange of experience and operational techniques.

Users of any local facility thus receive two important benefits: (1) availability of complete EASE computation and simulation equipment of latest design, at all times; (2) most advanced techniques, and an ever-growing fund of experience, as developed by all network members.

You are cordially invited to visit and investigate the nearest organization having an EASE facility, (see list below) and to discuss your problems involving mathematical analysis, system simulation and other phases of research, design or development work in which modern analog computer techniques offer substantial savings in time and cost.

**RICHMOND, CALIF.** (San Francisco area)
Berkeley division Beckman Instruments Inc.
Chalmer Jones: LAndscape 6-7730

**LOS ANGELES, CALIF.**
Dynalysis, Incorporated
E. Noneman: ARizona 7-6786

**BIRMINGHAM, ALA.**
Southern Research Institute
A. J. Thomas, Jr.: 54-2491

**ROSELAND, N. J.** (New York City Area)
Gawler-Knoop Co.
Allyn W. Janes: DIgby 4-8417

**CHICAGO, DETROIT, BATON ROUGE, MONTREAL**— facilities open soon.

***Computer application bulletins available on request... please address Dept. K8***

M-38

**Berkeley** *division* BECKMAN INSTRUMENTS INC.

2200 WRIGHT AVENUE, RICHMOND, CALIF.

ories of acoustics from the basic equations and their solutions through loudspeakers and microphone design, noise reduction and room acoustics. Included are equations governing the propagation of sound in free space and standing waves in enclosures.

Of particular interest to the engineer working with high fidelity music reproduction is the chapter on loudspeaker enclosures. Design of closed and bass-reflex boxes is reduced to simple chart form. The importance of jointly choosing the amplifier, speaker unit and enclosure so as to achieve the desired response curve is also presented.

### Proceedings of the National Electronics Conference Vol. IX

*6 x 9 in., 958 pp. Published by the National Electronics Conference, Inc., 84 East Randolph St., Chicago, Ill., $5.*

Included in this volume are all 98 technical papers presented at the Ninth National Electronics Conference, providing a permanent record of the technical material presented and furthering the Conference's objective of disseminating electronic information. The book's contents are separated into twenty-three categories: General; Circuits I and II; Magnetic Amplifiers; Audio and Microphonics; Servomechanisms; Ultrasonics; Materials and Components; Filters I and II; Television I and II; Electron Tubes I and II; Nucleonics; Computers; Network Synthesis; Transistors; Instrumentation I and II; Microwaves; Engineering Management and Communication.

### Direct and Alternating Currents—Theory and Machinery

E. A. LOEW, *Emeritus Dean of Engineering and Professor of Electrical Engineering, University of Washington; assisted by* F. R. BERGSETH, *Associate Professor of Electrical Engineering, University of Washington. 6 x 9 in., 637 pp. Published by the McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. $7.50.*

This fourth edition, in which all material has been brought up to date and much has been completely rewrit-


Electrol
Hand Pumps
for Uniform
2-Way
Pumping Action

The Electrol 525 Hand Pump has a volumetric capacity of 1.5 cu. in. per cycle.

The Electrol 770 Hand Pump has a volumetric capacity of of 2 cu. in. per cycle.

Electrol Double-Acting Hand Pumps are capable of delivering uniform volume, with operating pressures up to 1,500 P.S.I. They are compact in design . . . have few moving parts . . . are low in cost . . . economical in operation. They have built-in suction and pressure check valves . . . ⅜" pipe thread ports . . . and can be used in mineral oil or water. Also, there are similar units available for use in gasoline, kerosene, or equivalent aromatic fluids. Complete engineering data can be obtained on request.

Electrol
HYDRAULICS
KINGSTON, NEW YORK
Telephone, Kingston 1980

CYLINDERS • SELECTOR VALVES • FOLLOW-UP VALVES
CHECK VALVES • RELIEF VALVES • HAND PUMPS
POWERPAKS • LANDING GEAR OLEOS • SOLENOID
VALVES • ON-OFF VALVES • SERVO CYLINDERS • TRANSFER
VALVES • CUT-OUT VALVES • SPEED CONTROL VALVES

Better Designed Products Use Electrol Hydraulics

# STAINLESS fasteners in STOCK

All types and sizes of screws (Phillips, slotted, hex head, socket), bolts, nuts, washers, rivets, keys and pins

- Over 9000 items in stock means immediate delivery from one source
- New Garden City plant now operating at top speed and quality
- Unsurpassed facilities for quantity fabrication of specials
- A staff of seasoned engineers always available for consultation
- Pioneers in the manufacture of stainless steel fasteners

WRITE NOW FOR FREE COPY OF FASTENER MANUAL P18

MANUFACTURERS SINCE 1929

ALLMETAL

SCREW PRODUCTS COMPANY, INC.

GARDEN CITY NEW YORK

# BENSON MEANS *precision* GEARING

## FOR THE ELECTRONIC INDUSTRY *EACH GEAR "WRAPPED" IN IT'S OWN STORY . . .*

Which means that each gear is accompanied by a tape—assurance of uniformity and conformity to your specific requirements. BENSON utilizes the latest checking equipment and holds gears to rigid standards.

BENSON works only to the top classes of precision in small precision gears and gear assemblies. Our everyday work is in tolerances unheard of a few years ago on experimental and production gears. Our entire operation is set-up for the most exacting standards; and each gear is literally custom-made. If your problem involves real precision we can help you.

*Small precision gears*

SPUR—HELICAL—INTERNAL—BEVEL

CLUSTER—WORM & WHEEL ASSEMBLIES

*Send us your blueprints. Our specialists can help.*

# BENSON MARINE & GEAR CO.

8815 Ditmas Ave., Brooklyn, N. Y. • HYacinth 8-0869




ten, is a comprehensive treatment of the circuit theory and machinery of direct and alternating currents, suitable for use by electrical engineering students and other engineering students. Each section covers first, the fundamental concepts, and then goes on to a discussion of machinery and operating characteristics. Emphasis is placed upon basic principles rather than on specific groups of facts, in the belief that the operation of circuits and machines can be best understood through a knowledge of principles and laws.

Certain major changes have been made with this new edition. The rationalized *mks* system is used throughout, resulting in a change in approach in the early chapters, and to the complete rewriting of chapters on magnetism, electromagnetism, the magnetic circuit and the dielectric circuit. In the *a-c* section, a new chapter on conversion equipment has been added. New material was added to the chapters on transformers, alternators, synchronous motors, and electron tubes and rectifiers.

Throughout, the presentation is improved in clarity, accuracy and ease of understanding. Basic concepts and underlying theory are presented in sufficient detail to enable the reader to gain an intelligent understanding of the behavior of circuits and machine performance.

### Wave Motion and Vibration Theory

*Editor,* ALBERT E. HEINS, *Proceedings of the Fifth Symposium in Applied Mathematics of the American Mathematical Society; held at Carnegie Institute of Technology, June* 16-17, 1952. 7 x 10 *in.*, 169 *pp. Published by the McGraw-Hill Book Co., Inc.,* 330 *West* 42 *St., New York* 36, *N. Y.,* $7.

Here is a collection of 15 addresses on Wave Motion and Vibration Theory delivered at the Fifth Symposium on Applied Mathematics of the American Mathematical Society.

Reporting the mathematical methods in many diverse fields, the book is united by the general physical topics of wave motion and vibration theory. Each address is written by an outstanding leader in his field. Contributors and topics include: Hydrodynamic Stability, C. C. Lin; Examples of the Instability of Fluid Motion in the Presence of a Magnetic Field, S.

# another ROGERS innovation

**"Topee" test of paper-base laminates, with ten-inch flame applied for two minutes.**

At left, standard grade continued to burn after flame was removed. It was completely destroyed. At right, flame-resistant Rogers grade extinguished itself in less than eight seconds and retained most of its structural strength.

**WORK-HORSE MATERIALS MADE FLAME-RESISTANT**

BY WORK-HORSE, we mean our paper-base laminates, which are now available with exceptional flame-resistant qualities. The main purpose of these materials is to reduce costs in applications that now require glass-base laminates.

We have also added flame-retardant properties of our DUROID 800, a fibrous insulating material, listed by Underwriters' Laboratories as suitable for the sole support of current carrying parts. DUROID 800 is also self-extinguishing, but will not withstand as severe burning as our flame-resistant laminates.

Since industry-wide specifications for flame-resistant or flame-retardant materials do not exist, each of these Rogers materials should be assessed in terms of your application. Complete data are available, and we will be glad to supply samples for your own testing purposes.

Please write Dept. E, Rogers Corporation, Rogers, Connecticut.

INFORMATION WITH A LIGHT TOUCH . . . Please write for "Here's Rogers Again." It will help you appraise our company's place in your plans — at seconds-per-page speed.

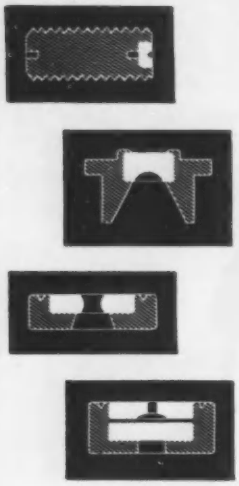
## REINFORCED CHEMICALS

Rogers specializes in combining fibers and chemicals to produce Fiberloys that meet special material requirements. We welcome problems that existing materials can't solve.

## ROGERS CORPORATION

ROGERS, CONNECTICUT

Bird COMPLETE JEWEL ASSEMBLIES WILL SPEED YOUR PRODUCTION



You'll be time and money ahead if you specify Bird complete jewel assemblies for your product. Rejects are eliminated, jewel breakage is minimized, and Bird jewel assemblies will keep your production running smoothly.

Bird Jewel Assemblies are furnished in the right mounting, rigidly inspected according to your specifications, ready for your assembly operations. Make a test — find out how Bird Jewel Assemblies can help your production. Send us a print of your specifications, and we'll provide samples for your own testing.

Our engineering staff is at your service for all small bearing problems.

*Over 40 years of serving industry with Quality jewel bearings*

Richard H. Bird & Co., Inc.

Sapphire and glass jewels · Precision glass grinding · Ferrite precision products · Sapphire stylii

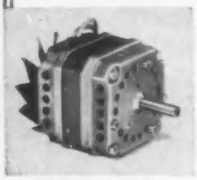
**1 Spruce Street, Waltham 54, Mass.**

LEWYT

Lear

CROSLEY
DIVISION OF AVCO

Tele King



Model No. MS–3600
Shaded Pole Motor

DY–88 Dynamotor

**Quality-Minded Manufacturers Demand Quality Motors**

The world-famous manufacturers, whose trade-marks you see above, can't afford to take chances with inferior rotary electrical equipment. The products they make must perform dependably — day in and day out — in order to protect and further the outstanding reputations of these companies.

Here at EEPCO we have worked with these industry leaders in the research and development of efficient, economical power sources for their products. In all cases, we have delivered from our production lines rotary electrical equipment that easily meets the extremely high standards maintained by these companies.

Whatever your problem is, whether it is a complicated dynamotor or a simple shaded pole motor, or armatures and fields, the EEPCO engineering staff is at your service to develop and produce the best unit for you.

Write, wire, or phone for complete details.

*ELECTRO ENGINEERING PRODUCTS CO.*
609 W. LAKE STREET, CHICAGO 6, ILLINOIS

• P-M DC MOTORS & GENERATORS • CAPACITOR TYPE MOTORS • UNIVERSAL MOTORS
• DC MOTORS & GENERATORS • SHADED POLE MOTORS (2-4-6 Pole) • P-M AC GENERATORS



Chandrasekhar; On Free Surface Flows, P. R. Garabedian; Review of Significant Observations on the Mach Reflection of Shock Waves, W. Bleakney; On a Nonlinear Differential Equation in Hydraulics, N. W. Mc Lachlan; Acoustic Radiation Pressure on a Circular Disk, Harold Levine; Infinite Matrices Associated with a Diffraction Problem (Abstract), W. Magnus; On the Coupling of Two Half Planes, Albert E. Heins and Herman Feshbach; On the Diffusion of Tides into Permeable Rock, G. F. Carrier and W. H. Munk; Some Remarks on Radiation Conditions, J. J. Stoker; On the Soft Obstacle, E. W. Montroll and J. M. Greenberg; Wave Propagation in Helical Compression Springs, E. H. Lee; On the Wave Equation and the Equation of Euler-Poisson, Alexander Weinstein; On Liendad's Differential Equation, S. Lefschetz; and The Effect of Small Constraints on Natural Vibrations, R. J. Duffin and A. Schild.

## Job Evaluation Methods

C. W. LYTLE, *Professor of Industrial Engineering, New York University.* 6½ x 9¼ *in.*, 507 *pp. Published by the Ronald Press Co., 15 East 26th St., New York* 10, *N. Y.*, $7.50.

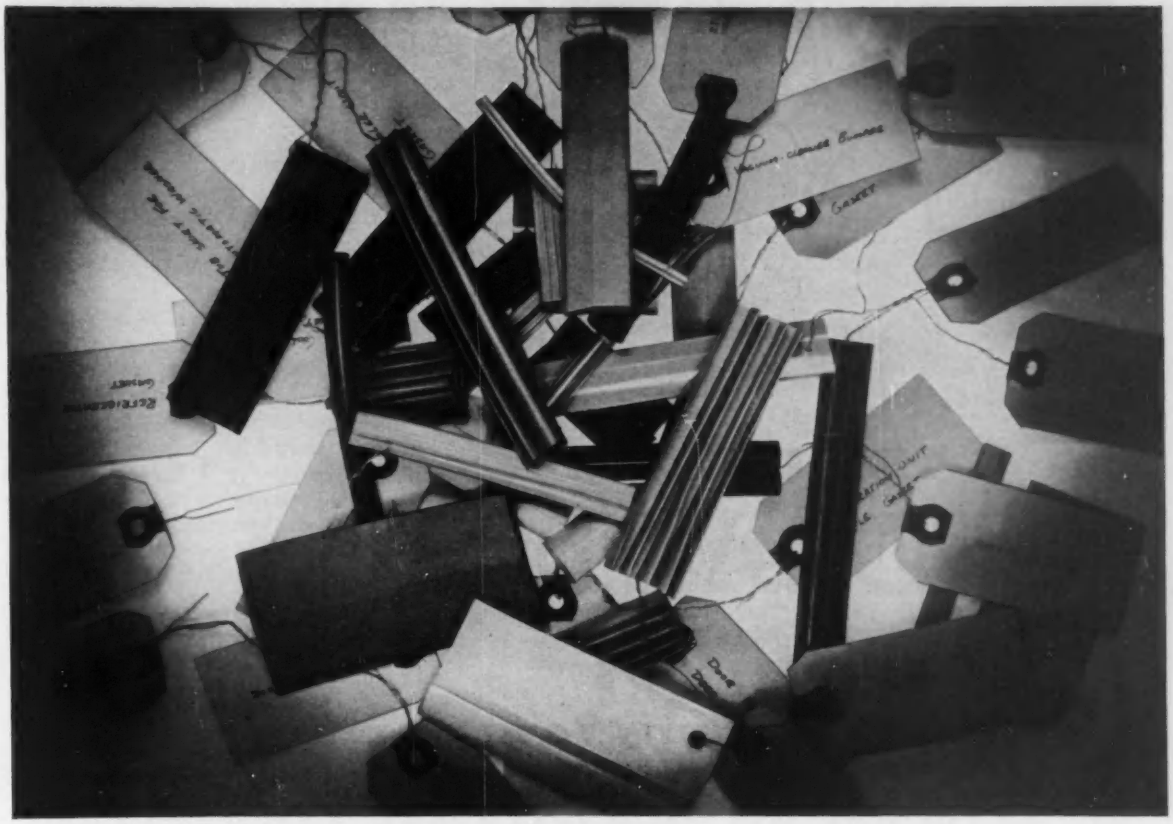
Since the first edition of this book, job evaluation has become far more widespread and experience with its methods has matured. Everyone in industry today, from top management down through the rank and file, needs to know about job evaluation. The methods and the results of job evaluation significantly affect policy making, public relations, collective bargaining, the day-to-day operations of business concerns, and, of course, all phases of industrial relations on all levels before and after hiring.

This volume—like the first edition of 1946—presents its subject analytically according to the functional steps that comprise the evaluation procedure. Each chapter is confined to a single phase of the whole procedure. Thus, successive phases such as policies, methods, measuring scales, etc., are treated one at a time so that each can be investigated thoroughly, comparatively and impartially.

In this edition, job evaluation has been applied to many jobs previously "exempt", such as supervisory, tech-

# Capture Color-Conscious Consumers

*with custom extruded vinyl compounds*



**SHAPES OF THINGS THAT CAME** to the aid of manufacturers seeking to increase the salability of their products are these attractively colored samples of functional, durable vinyl extrusions from Goodyear, St. Marys.

THE modern way to sell is with color. And many manufacturers—automotive, appliance and furniture, in particular—are meeting this consumer demand with colorful, durable vinyl extrusions. You can do the same—easily and economically—with the help of Goodyear and its recently expanded facilities at its big, modern molded and extruded goods plant in St. Marys, Ohio.

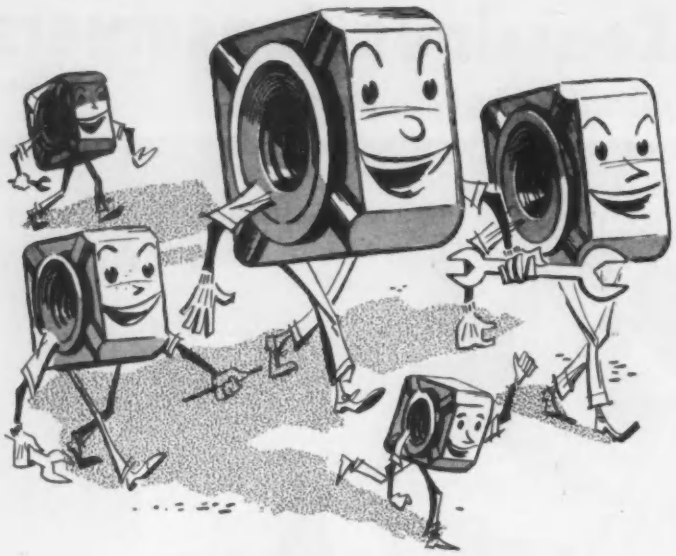
An unlimited range of colors—transparent, translucent or opaque—natural or metallic—is now readily available in unlimited cross-sectional design, unlimited lengths and unlimited quantities. Other outstanding properties include: A wide range in hardness. High strength. Excellent abrasion-, oil- and chemical-resistance. Low taste and odor levels. And again, low temperature and electrical properties comparable or superior to those of rubber.

Most important, however, are the services and skills awaiting your call at St. Marys. An expert group of engineers, compounders and production workers is ready, willing and able to help you improve the sales appeal of your product with quality vinyl extrusions turned out with the finest equipment available. Details? Design assistance? Just write: Goodyear, Industrial Products Division, St. Marys, Ohio or Akron 16, Ohio.

**GOODYEAR**

**THE GREATEST NAME IN RUBBER**

*We think you'll like THE GOODYEAR TELEVISION PLAYHOUSE—every other Sunday—NBC TV Network*



THERE'S A

MIDLAND

WELDING NUT

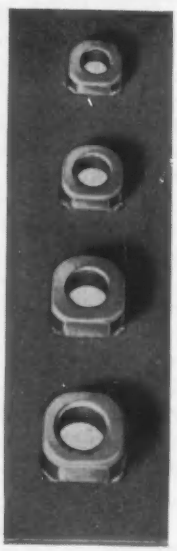
FOR EVERY SIZE JOB!

***For Fabricating, Fastening, and Assembling Metal Parts . . . Midland Welding Nuts are the Answer!***

No matter what your product—whether big or small—if there's metal fabricating, fastening, or assembling involved, chances are you can use Midland Welding Nuts to big advantage.

Now relied on by manufacturers the world over—and specified universally by product designers—Midland Welding Nuts will lower your assembly costs and speed up operations all along the line for you.

***Write or phone for complete information.***



**THE MIDLAND STEEL PRODUCTS CO.**

6660 Mt. Elliott Avenue • Detroit 11, Michigan

*Export Department:* 38 Pearl St., New York, N.Y.

*Manufacturers of*

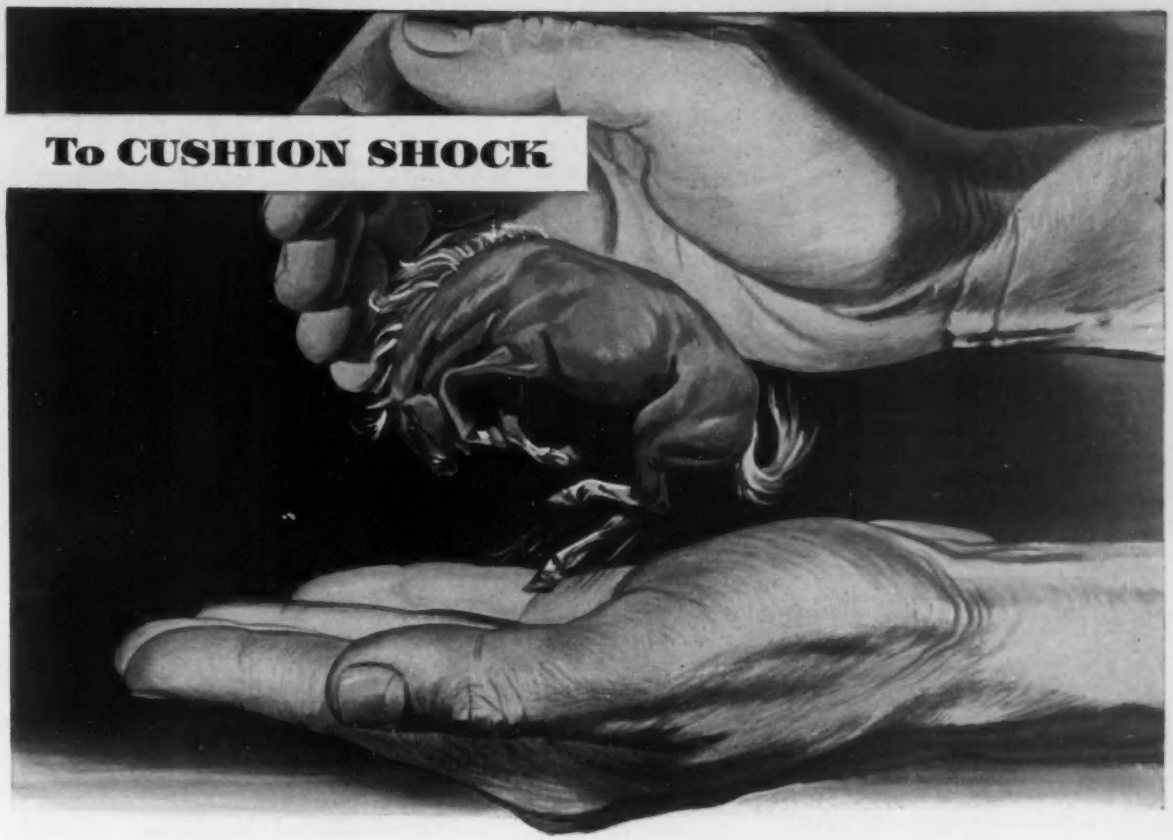
AUTOMOBILE AND TRUCK FRAMES | AIR AND VACUUM POWER BRAKES | AIR AND ELECTRO-PNEUMATIC DOOR CONTROLS



nical and high-level executive positions, and many of the recent, well-known cases are described and compared step by step. Much material has been added to the treatment of rate structures for solving the problems peculiar to this field; and the numerous combinations are worked out both in table and chart form to show the effects of assignable variables. The discussion of merit rating (which may or may not supplement job evaluation plans in actual practice) now includes the findings of psychologists who worked during World War II to establish more reliable man-rating. A wholly new chapter which high spots the principles of wage incentive methods has also been added. Many other changes have been made throughout the text to insure accuracy and a detailed, up-to-date exposition.

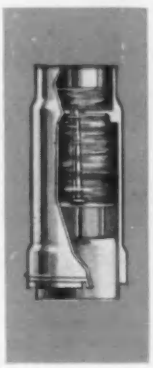
The job evaluation manuals of various companies and the numerous journal articles have unquestioned value, but these are almost entirely confined to single installations or to case history and explanations of particular plans. While such material should be carefully studied, case studies alone are not sufficient for the requirements of the serious student. Something more is needed—namely, a comprehensive and systematic survey of the subject—and this the author has undertaken to provide. He has written the book for the reader who wants to explore the field thoroughly by first learning the principles and fundamentals before proceeding in more detail to the exact ways in which plans are devised, set up, and made to operate smoothly. Thus, the analytic approach and the thorough presentation make this book readily adaptable for use in senior or graduate courses in colleges of engineering and commerce.

A few words should be said about the nature of job evaluation as it is understood in this book. Care, judgment, flexibility and imagination, rather than an exhaustive technical knowledge or training, are the prime requisites in undertaking evaluation. Obviously a plan will follow previous patterns and practices as to fundamental provisions, but each installation should be hand-cut as to details to fit the special conditions and needs of the individual company. This point is stressed throughout the book. There is such a thing as going too far in copying existing installations because




# Little bounces that mustn't grow up...

## ARE RESTRAINED BY AIR AND OIL



If you ever rocked a car to get it out of a mud hole, you know how effective those rhythmic little pushes were in building up the big push that eventually moved the car right out of the hole.

The helicopter manufacturers were running into the same rhythmic pushes . . . but *these* were causing trouble.

On the ground, the weight of the three rotating 'copter blades shifts unevenly from side to side. The slow side-to-side oscillation was building up waves of energy in the tires and landing-gear shock absorbers. Eventually, the waves grew big enough to tip over the helicopter in a mass of splintered rotor blades.

Our engineers developed a damper or *counter*-shock-absorber to squelch the little bounces *before* they build up into 'copter-wrecking forces. This damper is a part of the AEROL Landing Gear we designed and build.

Vibrations which start out small but build up into serious waves are a headache that many different industries are turning over to Cleveland Pneumatic engineers for a solution.

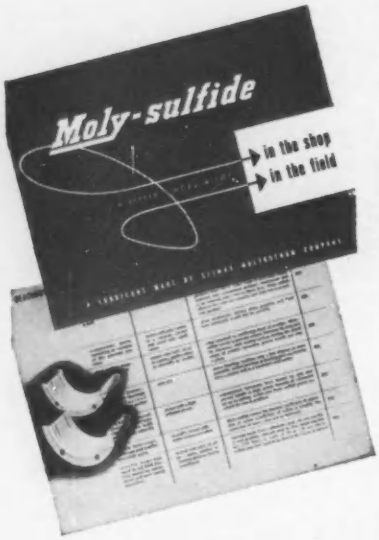
*Write for illustrated booklet E-8.*

**Cleveland Pneumatic**
*Tool Company* CLEVELAND 5, OHIO
Department E-8
BALL-SCREW ACTUATORS • AIR-OIL IMPACT ABSORBERS
*World's Largest Manufacturer of Aircraft Landing Gears*

## To MOVE with less EFFORT

Combining the screw with balls makes Cleveland Pneumatic's patented ball-screw actuator drive with as little as 10% friction . . . compared to as much as 50% for ordinary screw drives. You can cut the weight of a drive system, reduce its space, lessen its cumbersomeness, increase its control accuracy, and provide pin-point positioning. Let our engineers work out your ideas for our ball-screw actuators.

# 154 ideas on ways to use...




154 varied applications of molybdenum sulfide in the shop and in the field are described in a new booklet now available. This solid-film lubricant has demonstrated unique anti-friction properties under conditions of extreme pressure, high velocity, elevated temperature, or chemical attack.

The 40-page booklet contains the records of solved lubrication problems — some might solve your own. Fill in the coupon below, attach it to your letterhead and send it off today.

**Moly-sulfide**
*A LITTLE DOES A LOT*

*The lubricant for extreme conditions*

**Climax Molybdenum Company**
500 Fifth Avenue
New York City 36 N Y

Please send me your Free Booklet on *Moly-sulfide*
Name.....
Position.....
Company.....
Address.....

MOLY

PE-8 MS-6A




there are limitations in all such plans, working conditions vary in different companies, and no two groups of management and worker representatives see exactly alike on all points. Even after installation, plans usually need modification or additions from time to time. Employer's and employee's interests must be kept equally in mind at all times, and hence the author advocates a reasonable degree of participation on the part of unions in setting up and operating a job evaluation plan.

While the principles for an analytic approach to job evaluation do come from the study of previous experience, any temptation to present the material as an exact science or as a collection of standardized patterns has been steadfastly resisted by the author as not in keeping with the true nature of the subject. However, liberal use of forms, tabulations, charts presenting graphically the setup of rating curves, and illustrative case material from well-conceived and successfully operating installations help the reader to grasp and visualize the subject in its entirety.

## Engineering Contracts And Specifications

ROBERT W. ABBETT, Knappen, Tippetts, *Abbett, McCarthy, Engineers. 5½ x 8½ in., 429 pp. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., $6.*

This third edition is a basic legal guide to the administration of construction work. It contains a clear and concise description of the fundamental methods of preparing contracts and specifications, and a useful outline of the applicable principles of law pertinent to engineering and construction.

New material contained in this volume consists of: Engineering and Construction Law; Cost Plus Fixed Free Contracts; Construction Insurance; Bonding Practice; Contracts for Architectural and Engineering Services, and Specification Writing. The scope remains the same as the previous editions; however, about one-half of the book has been rewritten, and the total amount of material has been increased by 30 percent.

As in the past, emphasis is on how to write contracts and specifications, rather than merely what to write. The approach is the professional engineer's.


KRAISSL

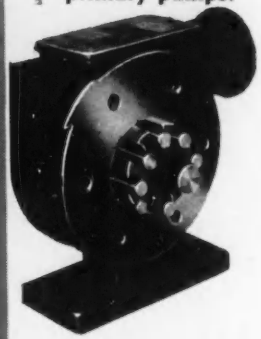
• Since 1926 • in the application, design and mfg. pumps—separators —hydraulic accessories.

**EQUIPMENT FOR FLUID POWER TRANSMISSION**

Primary Oil Pumps • Vacuum Powered Transmission and Low Pressure Air Service • Air and Liquid Filters •

**What's your problem?**

√ higher pumping speeds?
√ tolerance of particle-laden liquids?
√ peak suction for primary pumps?



**the Kraissl-50 Roller Pump**

is unmatched for dependable performance on every one of those counts.

Bulletin A-1330 has full data . . . write for it. The roller-rotor design easily handles particles that would jam more tightly-fitted mechanisms — reduces cavitation, allowing higher speed operation* — develops high suction characteristics.

*Roller mechanisms permit higher speeds with any oil than most displacement designs.

KRAISSL KRAISSL CO Inc.
289 Williams Ave., Hackensack

How to reduce costs with

# HUNTER DOUGLAS

# IMPACT FORGING

## FROM

## HIGH STRENGTH ALUMINUM ALLOYS

The above photo shows a typical size range of closed bottom tubes impact forged by Hunter Douglas from high strength aluminum alloys, 14S-T6 and HD 11. In the three types shown, the finished machined part is adjacent to its corresponding rough impact forging. Obvious graphic proof that minimum machining is required to produce a finished part.

The zero-draft feature of Hunter Douglas eliminates machining the I.D. of the tubes and reduces other machining operations to a minimum. Wall thickness may vary from .050" up to .500" with bases of any required thickness. The flange shown is also optional. Now produced in a single operation, formerly each of these tubes was fabricated from four different parts.

This new technique perfected by Hunter Douglas to mass produce high strength aluminum alloy parts with tolerance of an extrusion and strength of a forging cuts costs and increases production.

If your design demands a tubular shape with or without a closed end for mass production up to a million or more a month, remember the name Hunter Douglas. Our research and development engineers will be pleased to analyze your blue prints or sample parts without cost or obligation.

write for free literature on your company letterhead

**HUNTER DOUGLAS** *CORPORATION*

DEPT. PE-8 • RIVERSIDE, CALIFORNIA • TELEPHONE RIVERSIDE 7091

# OUR READERS SAY

## Another GE Engineer Boosts Simplified Drafting Methods

*To the Editor:*

As a contributor to General Electric's new book, "Simplified Drafting Practice," and as a draftsman of some experience in practicing the new ideas that are being preached, may I express my personal appreciation for the support given in the editorial, "Expensive Fancies," appearing in the December issue of Product Engineering. More specifically, I would like to comment on two letters reprinted in your April issue: first, on the comments of Mr. George E. Rowbotham, in which he took issue with the ideas contained in your editorial, and secondly, on the thoughts expressed by Mr. Sol Zwirn.

It is evident that Mr. Rowbotham's experience in drafting has been both extensive and varied. There can be no disagreement with him on the proper concept of drafting objectives and it is certainly reasonable that every Chief Draftsman should be most interested in drafting economy. However, after several readings of his comments, I am somewhat in doubt regarding the basis for several of his remarks.

### Drawings Stripped of Frills

Mr. Rowbotham's comments presented several strong arguments for the completeness and thoroughness of drawings and in this we heartily concur. The only basis for any such comments by him contained in the editorial was a phrase "drawings . . . reduced to their essentials." We are sure that the editor had no intention of implying that economy could be obtained by eliminating essentials. Our book states in the preface, "Drafting must be stripped of its frills without surrendering either clarity of presentation or accuracy of dimension." On Page 5 the book refers to the elimination of unnecessary work, and defines such work, "this means merely leaving off those things which added nothing to the accuracy, completeness or clarity of the drawing." A superfluous line is defined on Page 9 as "any line more than the minimum need to make a drawing which can be understood easily and which can be interpreted in only one way." These few quotations are typical of the general theme throughout the book and accurately reflect the thinking of those who have been concerned with drafting economy for sometime. I feel that these quotations should be conclusive evidence that we have no fundamental difference with him on the necessity for thoroughness.

### Accuracy—But Not Precision

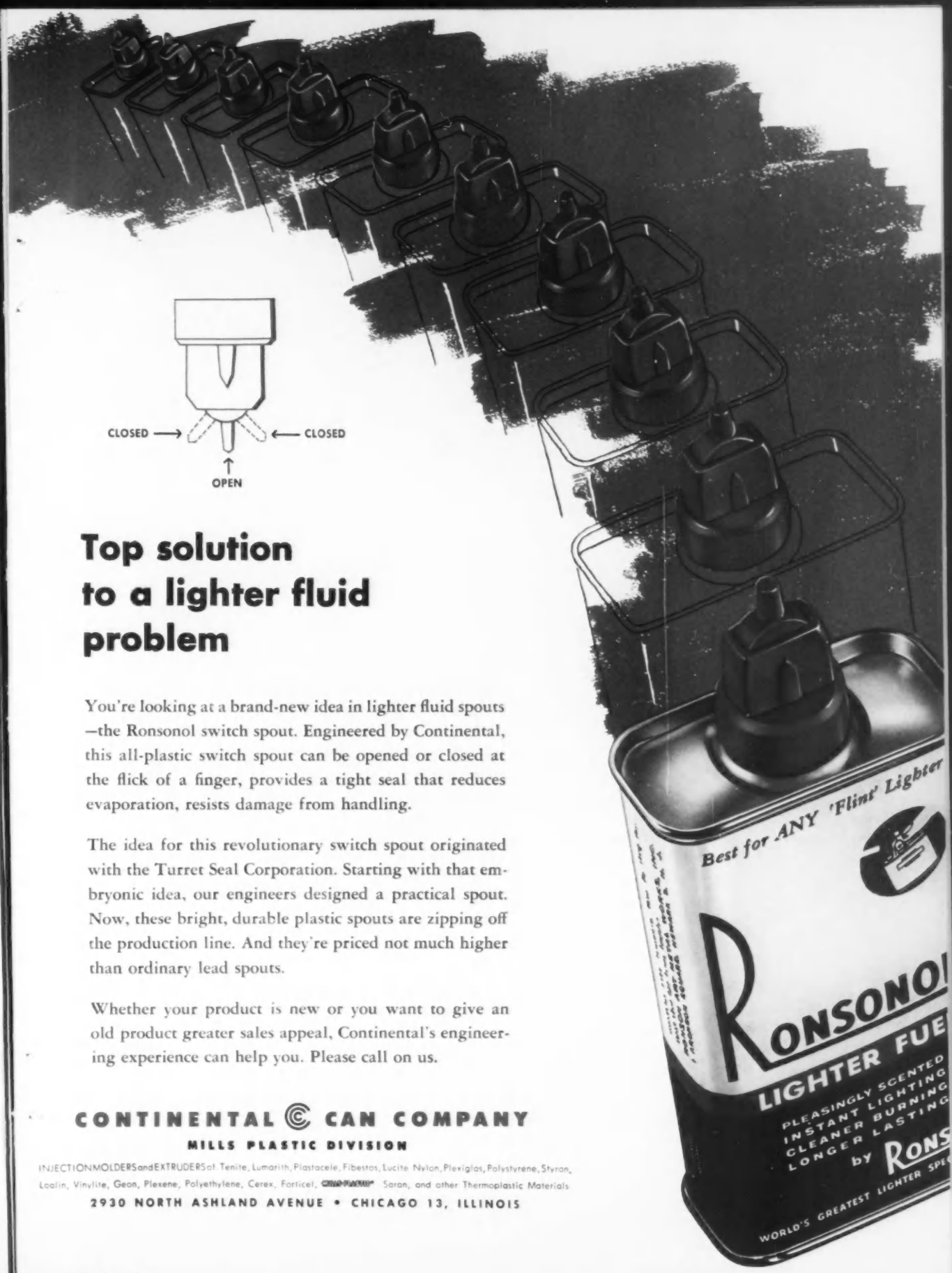
Mr. Rowbotham's comments regarding accuracy also created some confusion in my mind. Obviously, remarks pertaining to mistakes in design, poor designs, oversights and engineering routines for developing a design, have no bearing on drawing procedures since such errors or omissions can and do occur regardless of procedure. Your editorial stated that accuracy is a major yardstick "by which to measure worth while drawings." This, to me, indicates that you think very highly of the necessity for accuracy in engineering drawings. Our book on "Simplified Drafting Practice" attempts to point out on page 21 the differences between accuracy, which is of prime importance, and precision which merely adds to the cost of the drawing without increasing its value. Throughout the book are found such phrases as "information which must be complete, precise and accurate." On page 24, there is the statement ". . . it should be emphasized that those habits of accuracy, neatness, care, etc. which are essential to almost any drawing operation apply also in freehand practice. Freehand drawing is not an automatic license for careless, sloppy or indifferent work." I hope that these quotations will make it evident that we also have no fundamental differences with Mr. Rowbotham on the need for accuracy.

From here on there are some basic differences of opinion. I would like to point out that the book "Simplified Drafting Practice" resulted from the collaboration of a group of General Electric drafting supervisors of considerable experience. The methods outlined in the book are not theory or wishful thinking, but practices which have been evaluated and applied under actual working conditions, over relatively long periods of time, and in more than one location, under several supervisors. Only those methods which have proved conclusively to be improvement over more conventional and antiquated practices were included. Experience in the field has shown beyond doubt that simplification of drawings and the methods used to produce these drawings is effective in reducing the time of production, the overall cost and the ease of interpretation. We are in complete agreement with Mr. Rowbotham that drawings released for use must be complete, accurate and legible; however, our experience evidently is different in that we have found that simplified drawings can satisfy all of these basic requirements.

### Not Rough Sketches

Mr. Rowbotham's interpretation of a simplified drawing as "a rough sketch" is consistent with most critics of simplified drafting practice. I feel that his interpretation is based on a pre-conceived notion or pure assumption, since I could not find anything in your editorial to support such an interpretation. We are equally sure that there is nothing contained within our book "Simplified Drafting Practice" that established simplified drawings as "rough sketches." If there is such material it is strikingly contrary to our intentions and experience and we would appreciate having it brought to our attention for correction.

I was exceedingly interested in Mr. Rowbotham's statement regarding the interest of Chief Draftsmen in drafting economy. It has been our experience here within the General Electric Company, and other companies, that the pressure for economy lies largely in the reduction of direct scrap losses due to incorrectly manufactured items. Pressure on the drafting organization for economies in other areas is usually non-existent due to the lack of personal




# Top solution to a lighter fluid problem

You're looking at a brand-new idea in lighter fluid spouts —the Ronsonol switch spout. Engineered by Continental, this all-plastic switch spout can be opened or closed at the flick of a finger, provides a tight seal that reduces evaporation, resists damage from handling.

The idea for this revolutionary switch spout originated with the Turret Seal Corporation. Starting with that embryonic idea, our engineers designed a practical spout. Now, these bright, durable plastic spouts are zipping off the production line. And they're priced not much higher than ordinary lead spouts.

Whether your product is new or you want to give an old product greater sales appeal, Continental's engineering experience can help you. Please call on us.

**CONTINENTAL CAN COMPANY**

**MILLS PLASTIC DIVISION**

INJECTIONMOLDERSandEXTRUDERSof Tenite, Lumarith, Plastacele, Fibestos, Lucite Nylon, Plexiglas, Polystyrene, Styron, Loalin, Vinylite, Geon, Plexene, Polyethylene, Cerex, Forticel, [illegible] Saran, and other Thermoplastic Materials

**2930 NORTH ASHLAND AVENUE • CHICAGO 13, ILLINOIS**

*Trademark Registered*

# Production costs cut 90%

## WITH GRAY IRON

Gear cover fabricated from nine pieces. Arrows show cut-outs.

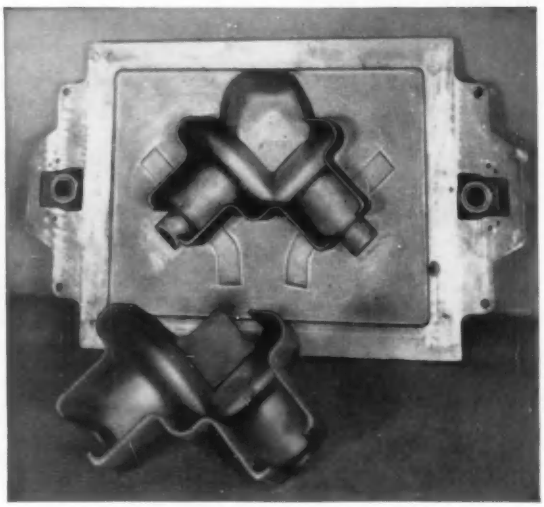
Made entirely in green sand, the Gray Iron castings were produced at one-tenth the cost of fabricated gear cover.

Formerly, nine separate pieces were shaped and welded into a fabricated gear cover for a braiding machine. Then, the manufacturer redesigned the gear cover for production in Gray Iron.

The finished and machined casting cost *less than 10%* of the production cost for the fabricated piece. This saving quickly paid for pattern-equipment costs . . . netting a *90% saving* on all parts thereafter. By redesigning for Gray Iron, the manufacturer not only made substantial savings, but obtained the advantages of a streamlined, vibration-absorbing gear cover.

Look at the structural and functional requirements of your fabricated parts. You can undoubtedly use the unique characteristics of Gray Iron—and the economy offered by this casting process. Why not write us for more information?

Matchplate and gear cover.



**GRAY IRON CHARACTERISTICS INCLUDE:**

| | | |
|---|---|---|
| Castability | Low Notch Sensitivity | Corrosion Resistance |
| Strength | Wear Resistance | Durability |
| Rigidity | Heat Resistance | Vibration Absorption |
| | Machinability | |

**MAKE IT *BETTER* WITH GRAY IRON**

**75% of all cast metal products are Gray Iron**

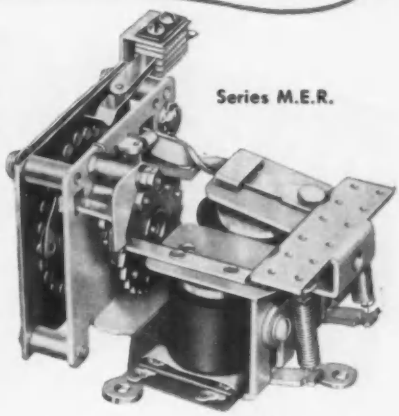
**GRAY IRON FOUNDERS' SOCIETY, INC.**

*NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO*

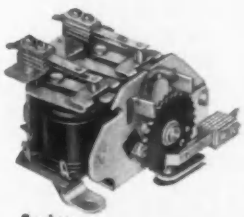
These *high precision* standard Guardian Steppers afford positive selection and control of multiple circuits in Business Machines, Counting Devices, Totalizers, Computers and a vast array of similar products *at low cost*. Applications include: automatic circuit selection; automatic sequence selection of circuits; automatic sequence cross-connection of circuits.

**SERIES M. E. R. GUARDIAN MIDGET ELECTRICAL RESET STEPPER**

Keeps the reset magnet open, allows the ratchet to reset freely on a pulse of 10 milli-seconds. Stepping magnet releases lock mechanism on first step to ready unit for recycle. Standard unit has one disk with one finger rotating counter-clockwise. Two fingers available. Up to 21 of total 24 points on disk are active. Rated at 10 steps per second. Voltage ranges: 6 v. to 115 v. A.C., 60 cycles, or 6 v. to 110 v. D.C. Auxiliary small combination contact switches can be mounted on ratchet or on either magnet. New 3-point mounting for easy installation.



Series M.E.R.



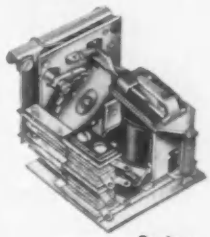
Series M.A.S.

**SERIES M. A. S. STEPPER**

A compact dependable Add and Subtract unit. Up to 27 active points on total of 30. Rated at 10 steps per second. S.P.D.T. contact switch can be mounted on any ratchet position or on either magnet. Available to operate on 6 v. up to 115 v. A.C., 60 cycles, or from 6 v. 110 v. D.C.

**SERIES M-120 STEPPER**

Up to 3 position contact combinations are available on the Guardian Series M-120 Stepper. 24 point ratchet employs case hardened steel construction to assure long life precision operation. Contact combinations in 3 standard ratings: 1.5, 10 and 12 amps. at 115v., 60 cycles, non-inductive. Voltage range: 6 v. to 115 v. A.C., 60 cycles; or 6 v. to 110 v. D.C. intermittent duty.



Series M-120

*Write* for catalogs featuring Guardian Steppers, Relays, Solenoids, Switches, Solenoid Contactors and Hermetically Sealed Controls.

**GUARDIAN ELECTRIC**

1603-J W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

FREDDY FEDERAL SAYS:
Hurdle ALL your Short Run Stamping Problems with ONE JUMP WITH Federal SHORT RUN STAMPINGS

COST
QUALITY
ACCURACY
SERVICE

SAVE UP TO 80% OF CONVENTIONAL TOOLING

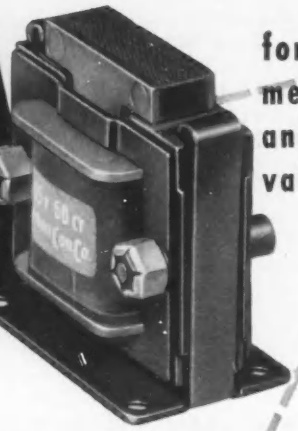
Willing to invest 3¢ on a sure winner? Federal leads in low cost, high quality "Controlled Tolerance" stampings, because they have complete die-making facilities and properly trained personnel to handle any job, large or small. Federal is equipped to stamp sizes and shapes up to 9"x12", and up to ¼" thick, in any quantity from 2 pieces to 10,000 from any stampable material (metal, fibre, phenolic, plastic, etc.) Be the winner by sending us your drawing today for quotation and prompt delivery schedule.

see our catalog in PRODUCT DESIGN FILE or write for copy

Write for bulletin 101

Federal TOOL AND MANUFACTURING CO.
3621 ALABAMA AVE. (ST. LOUIS PARK)
MINNEAPOLIS, MINNESOTA
"QUALITY STAMPINGS IN SMALL QUANTITIES"

Decco
INDUSTRIAL SOLENOIDS



for small mechanisms and light valving

Decco gives you a complete range of small, short-stroke, low-amperage, push or pull Industrial Type Solenoids manufactured with all the high quality of Decco Standard Size Solenoids. Built to J.I.C. specification, Decco Small Solenoids are shock-mounted to reduce self-destruction, have silicon steel laminations for efficiency, hardened beryllium-copper plunger guide, and heavy Formvar insulated magnet wire on high flow point molded nylon bobbins.

SPECIAL SOLENOID PROBLEMS ENGINEERED TO YOUR NEEDS

DETROIT COIL COMPANY
2435 HILTON ROAD • DETROIT 20, (FERNDALE) MICHIGAN



knowledge of up-to-date drafting methods by those who would normally exert such pressure. Chief engineers are often limited to that knowledge of drafting practices acquired in college and it is universally recognized that schools cannot satisfactorily maintain their information current with industry. Manufacturing and sales personnel generally have learned drafting practices through the study of existing drawings; the few changes suggested by such people are usually easily discouraged by drafting personnel.

In the final analysis, it is the customer who exerts the most effective pressure and many companies are becoming aware of that pressure through the necessity for shortened delivery schedules. Drafting must contribute its share to the reduction in schedule and thus simplification becomes mandatory, regardless of individual personal preference.

It is perfectly possible for one individual to be in disagreement with the great majority and still be right. However, when many individuals can successfully apply a new procedure or practice it would seem logical the dissenters should re-examine their position. It is evident from Mr. Rowbotham's comments that he has an intense interest in drafting. We sincerely hope that he will forward to us the results, either pro or con, of any extended trial he makes of simplified drafting practices.

### Instructions in New Practices

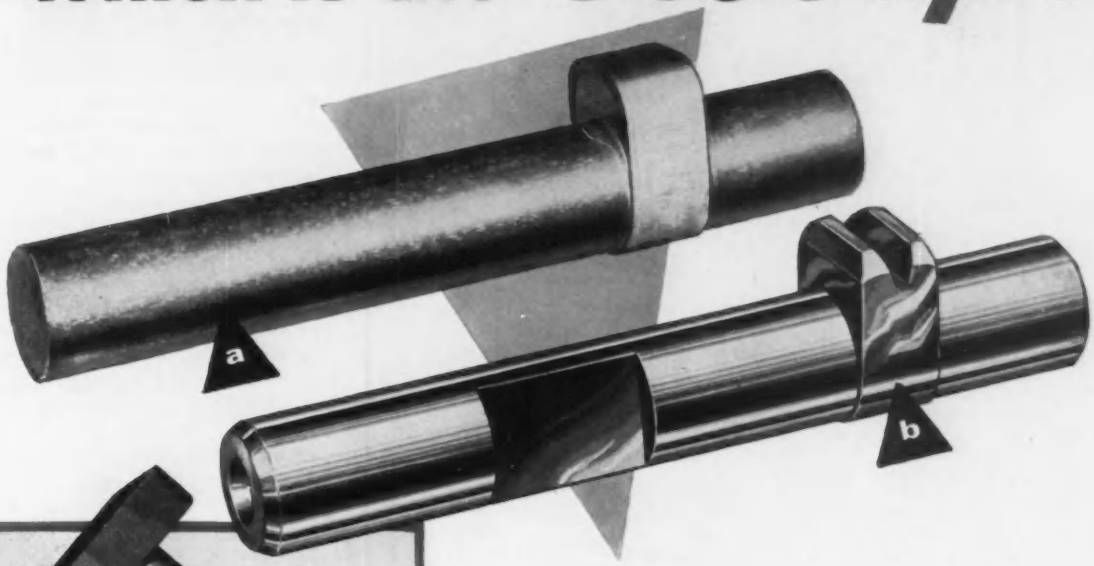
The general theme of Mr. Zwirn's letter, "instruction in a new practice or procedure requires considerable time and effort," is certainly one which brooks no argument.

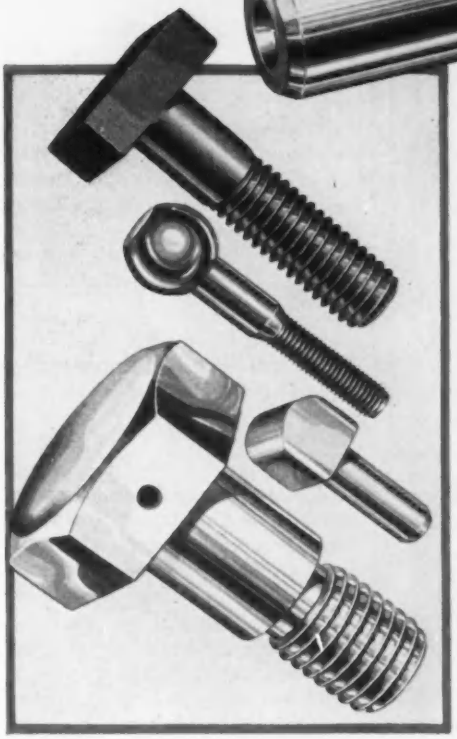
There are several methods of instruction that can be applied to advantage. The first of these is the preparation of a comprehensive drafting manual. Such a manual insures a high degree of uniformity in the preparation of drawings, which in itself is of tremendous assistance in simplifying the interpretation of drawings. A drafting manual should also be made available to those people who are required to use drawings.

The second feature in the installation of simplified drafting practice should be a thorough education of the interested users of drawings prior to the actual introduction.

Much of the simplification of draw-

# Which is the CleCap?



**...it could be both _____ made by fast economical CleCap processes**

It just might pay you to take a good look at the special parts you're buying that could be made more economically by CleCap's hot heading or cold extrusion processes. Quite a number of our customers have done it... and they like what happened.

The forged blank (a) above was produced for one user. He finished it as it's shown at (b). CleCap pre-forms your non-standard parts for further shaping and machining in your plant or manufactures them complete, ready for your assembly line. You'd be surprised at all the different shapes we've turned out.

You can save yourself tooling and machine time. Take a look at what CleCap offers—engineering skill and experience in applying high production methods and machines to your problems. Anyway, write for folder, "Specials by Specialists".

**Cleveland *Top Quality* Fasteners**

FERROUS AND NON-FERROUS

Hexagon Head Cap Screws • Socket Head Cap Screws—Plain & Knurled; also Flat and Button • Flat Head and Fillister Head Cap Screws • Place Bolts • Structural Bolts • Tractor Bolts • Square Head Set Screws • Socket Set Screws • Milled Studs

**The Cleveland Cap Screw Co.**

2936 EAST 79th STREET • CLEVELAND 4, OHIO

VUlcan 3-3700 TWX CV42

**Originators of the Kaufman DOUBLE EXTRUSION Process**

Seam welders welding aircraft parts

**BUILDING RESISTANCE WELDERS INTO PRODUCTION LINES IS A TAYLOR-WINFIELD SPECIALTY**

● How many welders do we need? What KVA for each operation? Press welders, projection welders, seam welders, butt welders? What type of operation? Why not call on the experience of Taylor-Winfield?

Taylor-Winfield can supply specific information about your production. For this practical help, "Call in T-W" and gain the benefit of facts, figures and experience with resistance welding.

Phone or write the nearest T-W district sales and service office.

*Resistance Welders Since 1898*

*Sales and Service*

CHARLOTTE • CHATTANOOGA
CHICAGO • CLEVELAND • DALLAS
DAYTON • DENVER • DETROIT
LOS ANGELES • PHILADELPHIA
PORTLAND, OREGON • SEATTLE
ST. LOUIS • STAMFORD • WASHINGTON
OAKVILLE AND WINDSOR, ONTARIO

TAYLOR-WINFIELD
RESISTANCE WELDERS

THE TAYLOR-WINFIELD CORPORATION WARREN, OHIO




ings involves only the elimination of non-essentials. Such elimination requires very little or no additional skill in interpretation.

If the above features are applied it will be interesting to note the ease and rapidity with which simplified practices are assimilated. Based on our personal experience, we feel that Mr. Zwirn's estimate of 20 years is slightly generous. —W. H. BUCHANAN
*General Electric Company*

*To the Editor:*

If some of the suggestions for simplification brought to light in Dean Gerardi's article are serious ("Should Current Drafting Practices be Further Simplified," *Product Engineering*, May, 1953), then God help industry. As a fellow draftsman and I were reading over it, he made a comment referring to Fig. 2, "What does a fellow have to be to know which side to counterbore—a mind reader!"

Let's not be too hasty in adopting such "screwy" ideas and in the meantime I'll do a little snooping around myself to do what I can to aid your quest for better efficiency in drafting practice. —JOHN HOMEWOOD
*Burbank, Calif.*

## The Term "Product Engineer"—Growing in Use

*To the Editor:*

We are regular subscribers to your excellent publication *Product Engineering*. Here in Canada, the professional term "Product Engineer" is virtually unknown and as professional consultants in this field of engineering we feel somewhat lonely.

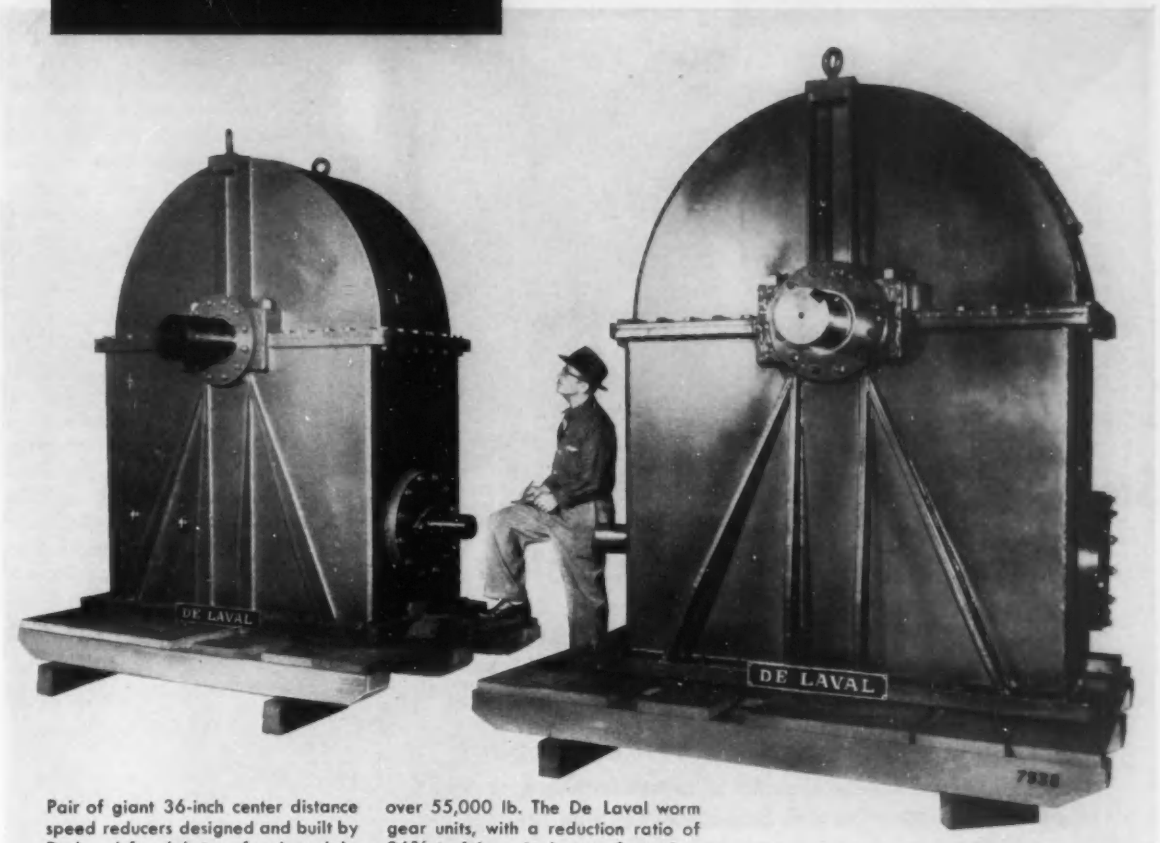
Is there an independent society or association of Product Engineers in the United States, or is this branch of engineering identified only as a section of other societies such as ASME?
—J. D. ORR
*Orr Associates*

Ed—At the time *Product Engineering* was launched in 1930, the title Product Engineer was rarely used. Master Electric Company of Dayton, Ohio, might have been one exception in their use of the title. Since that time, however, more and more companies have adopted the title, although it is not yet in what might be called general use.

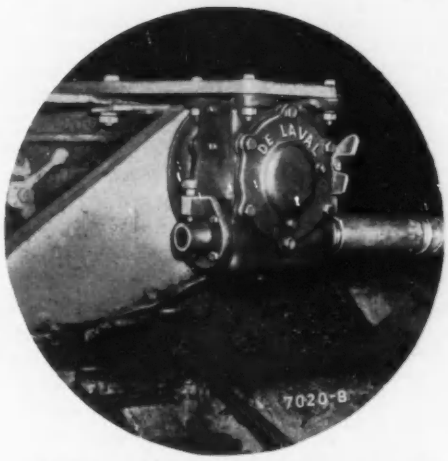
The title Product Engineer is used

# DE LAVAL
## SPEED REDUCERS

# *from dwarf to giant size*




Pair of giant 36-inch center distance speed reducers designed and built by De Laval for slab transfers in a slabbing-blooming mill. These slab transfers are used to convey steel slabs up to 12 in. thick and 42 in. wide, weighing over 55,000 lb. The De Laval worm gear units, with a reduction ratio of 26⅔ to 1 in a single set of gearing, are each driven by a 200 hp, 410 rpm motor coupled directly to the input shafts of the slab transfers.




Here's one of the smaller De Laval worm gear speed reducers with a 3″ center distance being used for a new coal drilling machine.

De Laval heavy-duty worm gear speed reducers seldom require attention under the most rugged operating conditions. They make a quiet, close-couple compact drive. They permit high ratio reductions in a minimum of space and withstand severe shock loads without damage. De Laval builds all sizes from 3″ to 36″ center distances for transmission ratios of 3.1:1 to 100:1 in single reduction units and ratios of 50:1 to 8000:1 in double reduction units. Whether you need dwarf or giant worm gearing, consult De Laval for engineering assistance. *Send for De Laval Manuals G-WBV and G-WWH containing data on single and double reduction units.*

**DE LAVAL** *Speed Reducers*

DE LAVAL STEAM TURBINE COMPANY

*801 Nottingham Way, Trenton 2, New Jersey* DL210

NOW!

## Stearns offers new magnetic disc brake for re-rated 3-20 hp motors

Stearns is first to provide motor manufacturers and users with the new H-70* series magnetic brake for re-rated NEMA frames in the 3 to 20 hp range. It is available in the following maximum torque ratings: — 10, 15, 25, 35, 50, 70, 75 and 105 lb ft.

The brake is designed to mount on new frame sizes 213 through 286. It is up to 15/16 in. shorter than previous brakes.

### New wear indicator feature

The Stearns H-70 brake has the new *manual release, automatic reset* wear indicator recently introduced on the new Stearns brake line. Like other Stearns models, the H-70 is supplied for either horizontal and vertical motor mounting or independent floor mounting.

### Power failure safety feature

Brake is spring set, solenoid released—stops motor automatically in case of power failure. It is available with either standard or dust-tight, water-proof enclosure.

*Get all the facts about this new Stearns brake. Contact your local Stearns representative or write today for new descriptive literature.* 1101

*Patent No. 2620901

MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

STEARNS MAGNETIC, INC., 631 S. 28th St., Milwaukee 46, Wis.



to distinguish between the plant engineer whose responsibility is the design and layout of the plant and the engineer whose responsibility it is to design the product. In some large companies the chief engineer was the man who took charge of all the plant facilities. The product engineer was called mechanical engineer. In more instances, the chief engineer title indicated the man who was responsible for the product design. The other man's title was plant engineer. That is still the situation in the vast majority of the companies in the United States.

To the best of our knowledge there is no independent society or association of product engineers. There is a machine design division of the ASME. There is also the Society of Industrial Engineers. The latter society is composed of men whose responsibility is to put sales appeal and attractive appearance into the product. The membership of more than 150 includes such prominent figures as Raymond Loewy, Walter Teague, Harold Van Doren and Henry Dreyfuss. The address of the Society of Industrial Designers is 49 East 49th St., New York 17, New York.

### Dumfound—And Vice Versa

*To the Editor:*

I think you are too sensible to be offended if I correct your spelling. In your Sans, Souci column in the April issue, you used the word "dumb," in reference to people who are stupid. You made the same mistake in the May issue and again in June.

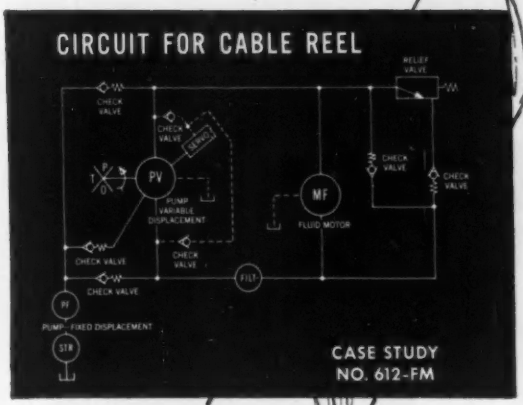
A dumb person is one having an affliction of the tongue that prevents him from speaking. Dumm is the German word for stupid. Just plain "deutschy dumm."

I'm not German. I'm Scotch. I just majored in languages along with art.

—PAULINE E. GARTH
*Kansas City, Mo.*

Ed—That strikes me dumb, meaning speechless. Miss Garth is correct. I can only crawl out of it by claiming that I used the term colloquially. My friend Webster says "(Partly from G. dumm in Pennsylvania); colloquially, U. S., dull; stupid." In other words, I must appeal to the Pennsylvania Dutch to "temper the wind to the shorn lamb."

# Shock loads can't hurt this fluid motor




## Denison Axial Piston Fluid Motors recommended for the toughest jobs . . . without qualification

● Quick starts, quick stops, stalling under load, continuous braking. These are the kind of conditions Denison Fluid Motors are built for. Where other motors fail, Denison hydraulic motors operate continuously . . . in conveying equipment, mining, drilling, construction machinery.

Through efficient axial piston design, Denison hydraulic motors pack high horsepower, high torque in a smaller space. The 400 series fluid motor is less than a foot long, weighs only 40 pounds . . . yet delivers 24 horsepower.

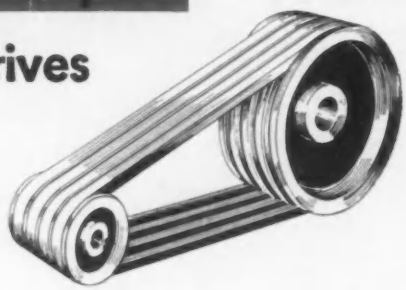
Denison Fluid Motors can be furnished to develop up to 180 horsepower, 5665 pounds-inches torque . . . for any hydraulic circuit to 5000 psi.

The circuit shows a Denison Fluid Motor that reels cable in and out of oil wells. For bulletins about Denison Fluid Motors, write to: THE DENISON ENGINEERING COMPANY, 1157 Dublin Road, Columbus 16, Ohio.

**PUMPS • MOTORS**
**CONTROLS • PRESSES**

DENISON
TRADE MARK
Hydr OIL ics

whether
it's multiple
v-drives



or fhp v-drives

**Maurey will meet your V-drive needs**

The chances are better than even that your V-Drive requirements can be met in full from the complete stocks of Cast Iron and Pressed Steel V-Pulleys, Sheaves, V-Belts and drive parts in the complete Maurey Multiple and FHP V-Drive lines. If you require special sizes or designs of V-pulleys, sheaves or parts, Maurey is staffed and equipped to meet your needs and stay within your budget.

On any V-Drive problem the help of widely experienced Maurey engineers is available to you *without obligation*. A more efficient drive and lowered cost often result from a Maurey engineering analysis.

Write us of your V-Drive problem . . . today. Ask for Maurey FHP and MULTIPLE V-Drive Catalogs.

maurey manufacturing corporation
2807-23 South Wabash Avenue • Chicago 16, Illinois
The Complete V-Drive Line . . . Serving Industry since 1917

F&H for MOBILITY at its BEST
WHEELS

Meet your wheel problems with "WHEELS by French & Hecht." Our experience, facilities and "Know-How" are your assurance of matured and tested recommendations—as well as wheel-hub-spindle-bearing assemblies perfectly suited to your requirements. In ONE engineered package, we offer you—

DESIGN of Wheels and HUBS
•
DESIGN of SPINDLES and AXLES
•
SELECTION of ADEQUATE BEARINGS
•
SELECTION of Suitable Closure SEALS
•
SELECTION of Sizes, Types, Rubber TIRES

INTEGRATED ENGINEERING — WHEEL BUILDERS FOR AGRICULTURE & INDUSTRY

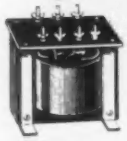
*We Invite Your Inquiries*

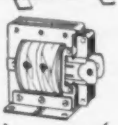
OUR PACKAGE PLAN
Our PACKAGE PLAN can save you Research, Development and Tooling Costs.

FRENCH & HECHT
DIVISION
KELSEY - HAYES WHEEL COMPANY
DAVENPORT, IOWA

2 THOROUGHLY EQUIPPED PLANTS and over thirty YEARS EXPERIENCE
bring you precision parts by

DORMEYER





**PRECISION-WOUND COILS:** Paper section, form and bobbin wound coils for practically every electrical purpose.

**QUALITY TRANSFORMERS:** Compact, efficient, transformers custom-built exclusively to your specifications.

**LONG-LIFE SOLENOIDS:** Solenoids constructed to exacting standards to assure long, dependable service.

**USE OUR COOPERATIVE SERVICE:** Send B/P, Sample or data for immediate estimate. No obligation.

D

DORMEYER INDUSTRIES
FACTORIES IN CHICAGO AND KENTLAND, INDIANA
3414 MILWAUKEE AVENUE • CHICAGO 41, ILLINOIS

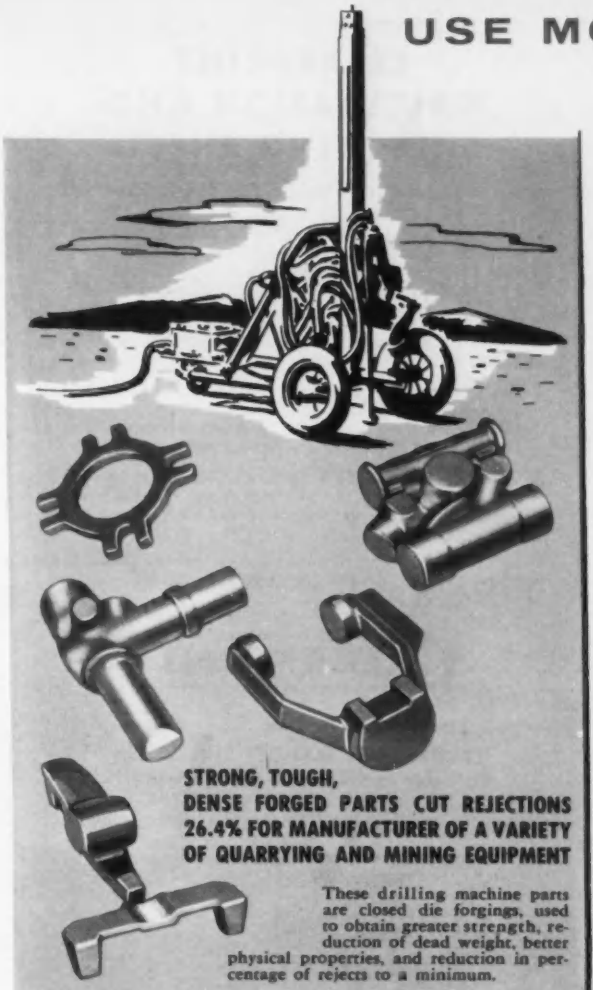
# USE MORE FORGINGS

## *get more*

# *Cost Reductions*

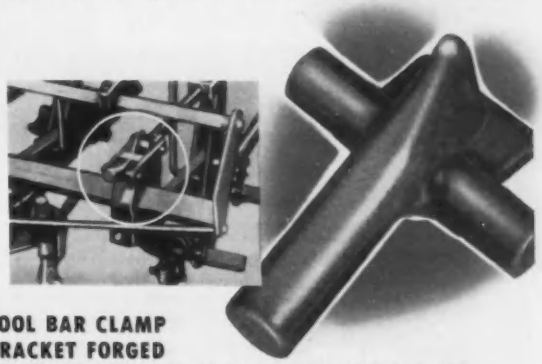
## *at the point of assembly*

A thorough "going-over" of each part of a product or mechanism to consider whether it can be or should be more efficiently produced will inevitably yield some worthwhile reductions in cost at the point of assembly. This process of examining each component may be accomplished in less time and with less effort than would first appear with the aid of Drop Forging "Problem Parts Charts" for design engineers, production executives, metallurgists and purchasing agents. These charts utilized along with the experienced skill of a forging engineer working with one or more members of a production team often reveal cost reducing possibilities heretofore undiscovered. Ask a forging engineer for a complete set of Problem Parts Charts.



**STRONG, TOUGH, DENSE FORGED PARTS CUT REJECTIONS 26.4% FOR MANUFACTURER OF A VARIETY OF QUARRYING AND MINING EQUIPMENT**

These drilling machine parts are closed die forgings, used to obtain greater strength, reduction of dead weight, better physical properties, and reduction in percentage of rejects to a minimum.



**TOOL BAR CLAMP BRACKET FORGED TO SHAPE, REDUCES COST OF MACHINING 12%**

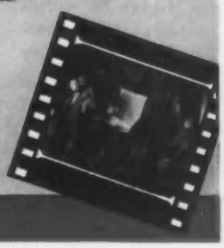
Key part of trigger latch for tractor-mounted cultivator, formerly a three-piece welded assembly built up from bar stock, now closed die forged in one piece. Results in increase of approximately 60% in number of parts completed per hour. Forging eliminates all but a simple drilling operation—no jigs, assembly or welding operations are needed.

**PARTS FOR LOCOMOTIVE GREASE GUNS PRODUCED 68% FASTER BY CLOSED DIE FORGING**

Manufacturer of "Spee-d" High Pressure Lubricating Units uses closed die forgings for gun handles, links, nozzle connections, bodies and engaging rings, and thereby obtains such advantages as greater strength and uniformity of physical properties, reduction in dead weight, and a 68% increase per hour in the production of finished parts.

This book tells why forgings are used for the toughest work loads. Engineering, production and economic advantages obtainable with closed die forgings are presented in this reference book on forgings. Write for copy today or attach coupon to your business letterhead.

A New Movie entitled, "Forging in Closed Dies," reveals all aspects of the closed die forging process of forming parts. Represents over ten years of planning and research. It is available for industrial training, sales training, instruction in engineering and metallurgy courses at the college level, and for technical, industrial and engineering societies. Write for information about loan of film without cost.



**DROP FORGING ASSOCIATION**
605 Hanna Building
CLEVELAND 15, OHIO

**DROP FORGING ASSOCIATION**
**605 Hanna Bldg., Cleveland 15, Ohio**

Please send 64-page booklet entitled, "Metal Quality" —How Hot Working Improves Properties of Metal," 1953 Edition.

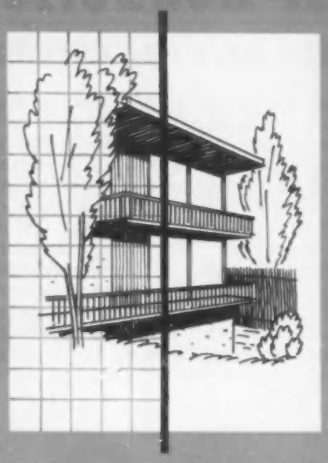
*Name* .....

*Position* .....

*Company* .....

*Address* .....

No grid, no ghosts appear on your prints!



## CLEARPRINT CALCULATION AND SKETCHING SHEETS

**with cross sections printed in "Fade-Out" blue**

Quick calculations and sketches to scale are easy with Clearprint "Fade-Out" sheets. They're printed on No. 1000H Clearprint, America's finest technical paper. Ask for a sample and make this convincing test...

1. **INVITES THE PENCIL** – Try Clearprint's perfect working surface with a 2H pencil. Your lines are sharp and clean – no feathery edges.
2. **ERASES PERFECTLY**–Erase some of the lines. Redraw and erase several of them time and again. Fold the paper repeatedly, too. Then hold it to the light and notice the absence of ghosts and grid lines.
3. **GHOST-FREE, GRIDLESS REPRODUCTIONS** – Make a quick, easy-to-read print of the sheet. Your original work is faithfully reproduced without erasure ghosts or cross section rulings.

If you are not using Clearprint now, please make this comparative test on the paper you are using.

CLEARPRINT®

**PRINTED WITH FADE-OUT BLUE LINES**

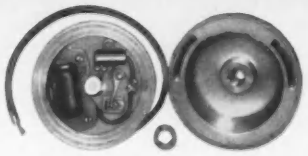
Available in standard size pads and sheets through 24" x 36".

Ask your dealer for samples, or write:

**CLEARPRINT PAPER CO.**

1482 SIXTY-SEVENTH STREET · EMERYVILLE, CALIFORNIA

## BIG NEWS FOR DESIGNERS OF SMALL ENGINES



A new flywheel magneto by Fairbanks, Morse & Co., builders of over 3½ million famous Super Spark Magnetos, is now available for small industrial engine application. This magneto sets a new standard in both electrical and mechanical life—molded heavy-duty high tension coil—large, long-lasting breaker points—Alnico permanent magnets—it's tops in operating efficiency and easy starting.

Engineering help is readily available—our competent ignition engineers will gladly give application assistance and further ignition data for easy starting and efficient operation of your engine. Get all the facts by writing today to Fairbanks, Morse & Co., Magneto Division, Beloit, Wisconsin.

FAIRBANKS-MORSE

*a name worth remembering when you want the best*

MOTORS • ZC ENGINES • MAGNETOS • PUMPS • DIESELS

Fine quality Gears can now be STAMPED by Winzeler, with a degree of *uniform* accuracy you never thought possible! That's why they are used so successfully in many unusual applications. Extremely skillful tooling, stamping and assembling by staking, brazing or riveting performed with speed and low cost efficiency in production runs only! Stock and custom dies. Ask our capable engineers for ideas and cost estimates.

**SEND FOR** *4-page folder containing valuable Stamped Gear data and tables. Write today!*

WINZELER Stamped Gears

WINZELER MANUFACTURING & TOOL CO.

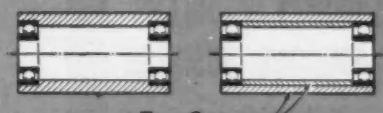
1712 WEST ARCADE PLACE, CHICAGO 12, ILLINOIS

**COSTLY PIPE, TUBING, MACHINE TIME, SCRAP, INVENTORY, HANDLING**

# SAVE MONEY

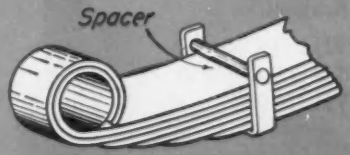
## With Plain Steel SPACER TUBES

## Sleeves, Bushings Ferrules

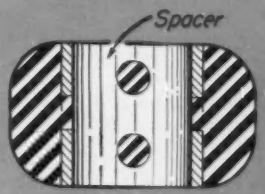


*Two Spacers*

**Left—undercut machined wheel hub. This costly screw machine part was replaced . . . (right) . . . with two low-cost, nested, hand friction-fit spacers.**




**Leaf spring bolt spacer.**




**Steel insert sleeve, molded into nylon, provides anchorage for the nylon.**

It is easy, quick and economical to order direct from this catalog. Spacers are money-saving, efficient replacements for costly machined parts, pipe or tubing (with concentricity held much closer). They come ready for assembly, eliminate machine time and scrap, and raw material handling in your plant. Order direct and save!

*Write Today For Your Copy!*

Your business letterhead request brings the new catalog and price list. See the savings you make with spacer tubes. Ask for your copy *today!*

**FEDERAL-MOGUL**

SINCE FEDERAL Mogul 1899

**FEDERAL-MOGUL CORPORATION**
**11043 SHOEMAKER • DETROIT 13, MICHIGAN**

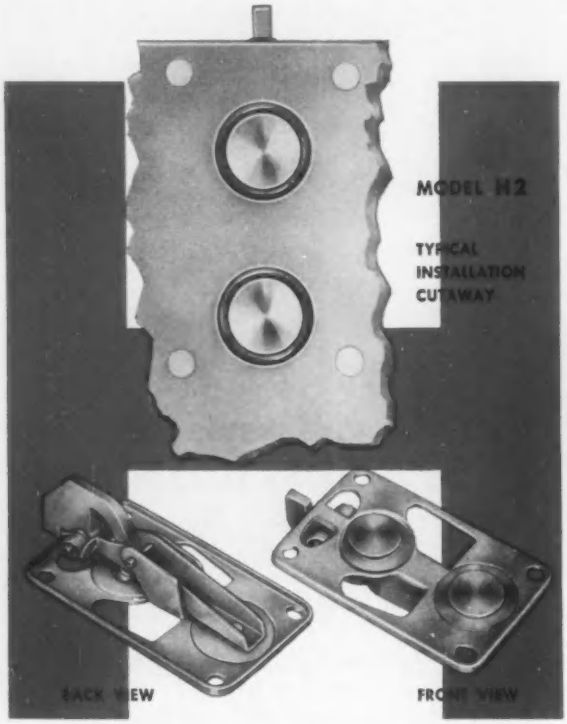
*New*

# HARTWELL

**Push Button**

**Trigger Action**

**FLUSH LATCH**




● A new latch development for modern equipment. Combines the desirable features of push button operation with the positive simplicity of trigger action in a small, rugged, lightweight yet inexpensive flush latch.

Available in many offset combinations for various door and frame thickness arrangements. Standard with or without gaskets in stainless steel or cadmium plated cold rolled steel.

*Write for new 48 page 2-color Catalog. Illustrates and gives full details of complete line.*

**HARTWELL**

**COMPANY**

*Manufacturer of Flush Latches and Hinges, Fittings and Cable Terminals.*

9035 Venice Boulevard, Los Angeles 34, California

*Space Savers*

**SPLIT BALL BEARING BUSHINGS**

. . . giving both radial and thrust capacity

They have solved many design and operation problems. . .

SHEAVES FULCRUMS IDLERS

CAMS OSCILLATING MOTIONS

Shaft rotation at moderate speeds. Lubricated for extended operation. Only a quarter inch section height. For shafts from 7/16" to 1½".

Ask for folder giving sizes and load capacities. Call on our Engineering Department for advice and help on your applications.

**SPLIT BALLBEARING CORP.**

LEBANON NEW HAMPSHIRE



**GASKET PROBLEMS ARE OUR BUSINESS**

Vellumoid's experience with a wide range of non-metallic materials is at your service. We work to many Government specifications.

VELLUMOID
444 VELLUMOID
VELBESTOS
(Compressed Absestos)
VELLUTEX
VELCOREX
VELBUNA
THIOKOL & BUNA N.
Coated

*Ask for our free Technical Data Book and samples for testing.*

THE **VELLUMOID** CO.

Worcester (6) : Mass.

*It's welded—*
*but you can't feel the weld*

*It has to be accurate*

*It's easy to fabricate*

## *Specify Brainard* FOR WELDED STEEL TUBING

• Brainard welded tubing is an economical structural material, and offers many physical advantages. It has a smooth exterior, with all weld flash removed. Its wall thickness is uniform, since it is formed from flat strip. With welded tubing you can cut weight without sacrificing strength. And there's practically no limit to the design requirements you can meet with this easily fabricated material.

Brainard maintains continuous quality control throughout manufacture—from ore to finished tubing. Careful supervision assures you high quality. For complete specifications call or write Brainard Steel Division, Dpt. GG-8 Griswold St., Warren, O.

Brainard

SHARONSTEEL

STEEL DIVISION
SHARON STEEL CORPORATION

**$700 saved . . .**

**more efficiency gained**

**with**

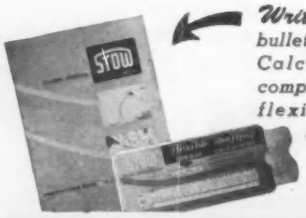
STOW flexible shafting

courtesy IOWA MFG. CO.

That's the experience of the IOWA MFG. CO., manufacturers of this super-tandem crushing plant which employs a 1¼" STOW power drive shaft, operating at 800 RPM. A centrifugal clutch relieves sudden starting loads. Use of the flexible shaft as shown permits a swing of up to 90 degrees either side of the center line.

***This is another fine example proving the efficiency, the practicability of STOW flexible shafting.***

Why not consult with STOW engineers on your next power transmission problem. You'll find that Stow flexible shafting can really do a job for you!



***Write today** for this free bulletin 525 and Torque Calculator, containing complete data on STOW flexible shafting. No obligation, of course.*

STOW MANUFACTURING CO.
136 State St.,
BINGHAMTON, N. Y.



The pick of the field-
**ARco**
RUBBER INSULATED METAL PARTS . . .

● Standard or special ARco clips, clamps and other rubber insulated metal parts . . . these can add electrical and sound insulation; corrosion and abrasion resistance to cable, loom, tube, wire, rod and pipe products.

You can improve the utility and durability of your product by requesting expert ARco engineering counsel; sample rubber insulations on your standard parts, and quantity estimates. These ARco services are yours without obligation.

*Valuable literature available—Write today!*

ARco
AUTOMOTIVE RUBBER COMPANY · INC.
*Manufacturers • Designers • Engineers*
12550 BEECH RD. • DETROIT 39, MICH.
ARco RUBBER PROCESSORS
4011 Homestead Rd. • Houston, Texas

ANYTHING CAN BE COVERED WITH RUBBER BY . . . ARco



# GEARS

**of every description—**
**made to your specifications**

The gears you buy from E. B. Sewall are made by men who are fussy about specifications. They've got the finest equipment and know how to use it. If you specify .0002" tolerance, you get it—at each tooth on every gear we ship. We're in a brand new plant, equipped to handle your gear requirements. Send specifications and quantity for our quotation.

**Your inquiry will be answered promptly**

# SEWALL

**E. B. Sewall Mfg. Co., 704 Glendale St., St. Paul 14, Minn.**

*weight lifters aren't always available*

**KEEP YOUR PRODUCT**

*Lightweight!*

## *Power Products new industrial engine offers*

# 60% *less engine weight*

# 42% *less engine size*

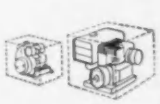
NOW you can give your power equipment the Lightweight being demanded by all of industry. Power Products engines are not just a little lighter—they're 60% lighter than any currently available industrial engine of comparable horsepower . . . and that means greater portability for equipment. Wheels, carriages, etc., formerly necessary for portability, can be eliminated in many cases, allowing further streamlining and extra weight and cost savings.

Power Products engines are more compact in design — easy starting — offer sustained performance at high speeds and are easier to service than any other industrial engines. Yet they actually cost less!

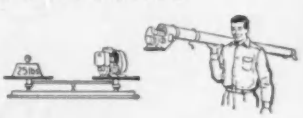
If you want better acceptance — better performance for any industrial product that requires from 2 to 4 horsepower . . switch to Power Products Lightweight!

### LOOK AT THESE FEATURES

**Lightweight** — A standard 3½ H. P. industrial engine weighs as much as two and one half Power Products industrial engines of 3½ H. P.



**Compact**—A unique design makes this engine amazingly compact. A comparison of overall dimensions shows a saving of 72% in size over the standard engine.



**LOOK AT THE RESULTS**—"Pump and motor weigh only 25 lbs.," reports a leading pump manufacturer. This is typical of the kind of amazing lightweight products these engines make possible.

"Only 41 lbs., and usable anywhere, at any angle." Grain auger manufacturers are among the many who have found it possible to revolutionize their products with these engines.

**POWER PRODUCTS CORPORATION**

**2013 N. 12th Street Grafton, Wisconsin**

Gentlemen:

I know what important advantages weight saving can give my products. Please send me full information on these new engines.

Name.....

Company.....

Address..... State.....

***For long life under extreme conditions of shock, vibration, corrosion, humidity and temperature***

**Bendix W type**

# HEAVY-DUTY ELECTRICAL CONNECTOR

Here is the electrical connector designed and built for maximum performance under rugged operating conditions.

Intended for use with jacketed cable and not requiring ground return through mating surfaces, this connector incorporates sealing gaskets at all mating joints.

W-Type Bendix* Connectors also incorporate standard Scinflex resilient inserts in established AN contact arrangements. Shell components are thick-sectioned high-grade aluminum for maximum strength. All aluminum surfaces are grey anodized for protection against corrosion.

For the real tough jobs, be sure to specify the W-Type Electrical Connector.

Our Sales Department will gladly furnish complete specifications and details on request.

*REG. TRADE-MARK

**SCINTILLA DIVISION**

SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Bendix

Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

FACTORY BRANCH OFFICES: 117 E. Providencia Ave., Burbank, Calif. Stephenson Bldg., 6560 Cass Ave., Detroit 2, Mich. • 512 West Ave., Jenkintown, Pa. • Brouwer Bldg., 176 W. Wisconsin Ave., Milwaukee, Wisc. • American Bldg., 4 S. Main St., Dayton 2, Ohio • 8401 Cedar Springs Rd., Dallas 19, Texas

# Imperial

THE *Finest* TRACING CLOTH

Imperial is known in drafting rooms all over the world as the traditional quality tracing cloth.

With the background of decades of experience, its makers have pioneered in modern improvements to maintain Imperial as the finest tracing cloth made.

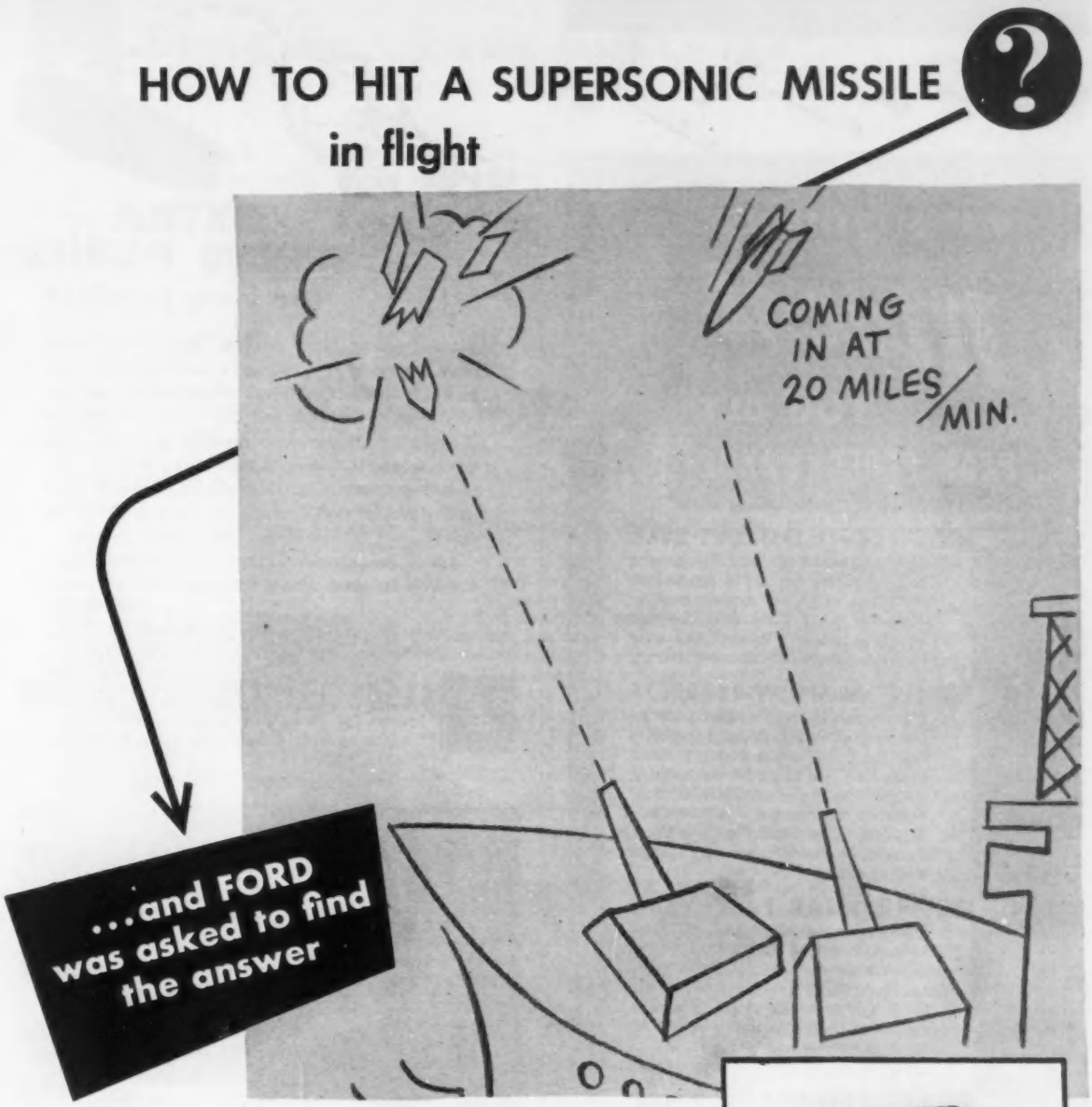
# Hartford PRECISION BALLS *to your specifications*

Chrome alloy balls for every requirement. Also stainless steel, bronze, Monel; K. Monel, aluminum, copper, glass, plastic, and drilled balls. Also special bearings and retainers. Just send your specifications to our Engineering Department.

THE HARTFORD STEEL BALL CO.
Hartford 6, Connecticut

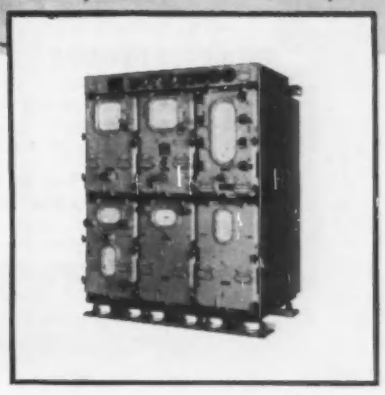
| DETROIT 2 | CHICAGO 6 | NEW YORK DISTRICT | MINNEAPOLIS 6, MINN |
|---|---|---|---|
| W. S. TURNER<br>445 NEW CENTER BLDG. | VICTOR R. CLARK<br>605 W. WASHINGTON BLVD. | NEWARK 2<br>1060 BROAD ST. | F. W. GIFFEN & CO.<br>2644 34th AVE. SO. |
| WICHITA 1, KAN. | KANSAS CITY 6, MO. | LOS ANGELES 15 | EXPORT OFFICE |
| A. E. WERNER<br>ORPHEUM BLDG. | T. R. WHITE<br>1915 BALTIMORE AVE. | E. D. MALTBY CO.<br>1770 SOUTH FLOWER ST. | R. A. RODRIGUEZ, INC.<br>55 W. 42nd ST., NEW YORK 18 |

# HOW TO HIT A SUPERSONIC MISSILE in flight




An enemy guided missile comes winging towards our task force . . . at speeds of up to 20 miles a minute. What kind of computer can predict and compute the necessary data fast enough to shoot down the missile . . . and be reliable every time? That was the problem posed to Ford Instrument Company engineers . . . and in cooperation with the Navy, they found the answer. Compact equipment, housed in easy-to-service units . . . that stand at the front line of our defense.

This is typical of the problems that Ford has been given by the Armed Forces since 1915. For from the vast engineering and production facilities of the Ford Instrument Company come the mechanical, hydraulic, electro-mechanical, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.



22

**You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.**

FORD

**FORD INSTRUMENT COMPANY**

**DIVISION OF THE SPERRY CORPORATION**

**31-10 Thomson Avenue, Long Island City 1, N. Y.**

HOLLOW LOCK SCREW • STRIPPER BOLT OR SHOULDER SCREW • FLAT HEAD SOCKET SCREW
SOCKET HEAD CAP SCREW • HOLLOW SET SCREW • HOLLOW PIPE PLUG • SOCKET SCREW KEY

WHEN YOU USE

**Mac-it**®

YOU GET

PEAK PERFORMANCE

**STRENGTH WITHOUT BULK**

Lower cost, smaller size Mac-it Screws can be used for all fastening jobs because of their exceptional tensile and torsional strength. Made from special Mac-it Alloy Steel held to rigid specifications, Mac-it Screws insure uniform and dependable screw performance.

**SPECIAL SCREW PRODUCTS**

Mac-it is geared for large or small run production of screws with special design or strength characteristics. The high quality of Mac-it special Alloy Steel adapts it to heat treatment that penetrates throughout the screw structure so that the center possesses the same sturdy toughness as the outside. Each type Mac-it Screw is heat-treated for maximum strength in its specific use.

**PRECISION FASTENERS**

The precision manufacture and quality control used in making Mac-it Screws provide users with high dimensional accuracy and uniformity. All Mac-it Screws in both coarse and fine threads are held to a class-3 fit. Mac-it maintains a fastener engineering service for the design, development and production of screws for all types of applications.

**DISTRIBUTOR SERVICE**

Contact any of the hundreds of Mac-it distributors from coast to coast for immediate service to supply your requirements for standard or special screw products.

MAC-IT SCREW DEPARTMENT
STRONG, CARLISLE & HAMMOND COMPANY
1392 W. 3RD. STREET • CLEVELAND 13, OHIO
Manufactured by Mac-it Parts Co., Lancaster, Pa.

Contact your nearest Mac-it Distributor or the Home Office, Cleveland, Ohio, for full information on how Mac-it can solve your screw problems.

HEX HEAD CAP SCREW • ROUND HEAD SCREW • FLAT HEAD SCREW • MINING MACHINE SCREW
SLOTTED SET SCREW • SQUARE HEAD SET SCREW • TOOL POST SCREW • FILLISTER HEAD SCREW

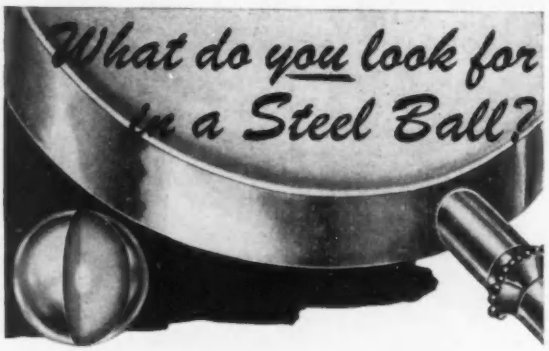
**EXTRA SPRING POWER for your product**

For that reserve power so often needed, for a longer, more even delivery of energy under all conditions — look to Sandsteel "Crosscurved" Mainsprings. In addition to superiority in torque and even power delivery, the "Crosscurved" Mainspring is preferred by product engineers because a longer, thinner spring can be used, permitting space saving within the mechanism. Highest-quality Swedish steel is used — steel able to receive the reserve-power benefits of the "Crosscurving" process.

Ask us about Sandsteel "Crosscurved" Mainsprings — whenever flat power springs are required in your product.

Write for our FREE brochure — "Sandsteel Springs for Your Products" — Dept. 94

**SANDSTEEL SPRING DIVISION**
SANDVIK STEEL, Inc.
145 HUDSON STREET, NEW YORK 13, N. Y.




- Precision—with tolerances held to ten thousandths?
- Guaranteed Uniformity—of size and shape within each shipment?
- Finish—glasshard and mirrorlike?
- Deep hardened and tempered carbon steel construction?
- Shock resistance—with high load-carrying ability?
- Packaging—which assures "factory-fresh" delivery?
- Lower Costs and Greater Adaptability—to meet more of your ball requirements?

*YOU'LL FIND ALL THESE FEATURES IN ABBOTT . . . THE BALL WITH THE ARMORED HEART!*

Write for details.

**THE ABBOTT BALL COMPANY**
55 RAILROAD PLACE
HARTFORD 10, CONN., U.S.A.

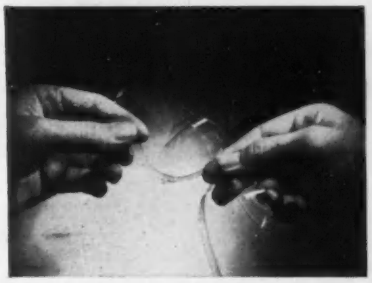
ABBOTT

# CORNING GLASS BULLETIN

FOR PRODUCT DESIGNERS

***Ribbon glass by the yard.*** Here's a glass that's a thousandth of an inch thin and in small widths it's flexible as—well, a ribbon. You can twist it, roll it, wrap it around your arm without cracking it. It comes in any length you want—inches, yards, miles.

Actually ribbon glass isn't a single glass. We can make it of several different compositions according to what you need it for. Originally we developed it to take the place of mica in electronic capacitors of which there are several in your radio and TV sets and in any other piece of electronic equipment you can name. As mica is formed in layers, it is subject to cleavage in the plane parallel to lamination; ribbon glass being homogenous is easily workable. This is just one advantage of this glass in capacitors.



Medical scientists have found a quite different use for ribbon glass—as microscope slide covers. These are the wafer-like pieces of glass that are used to cover blood smears and the like for examination under the microscope. In this case ribbon glass can be made clearer, flatter and more free of bubbles and striae than previously made glasses.

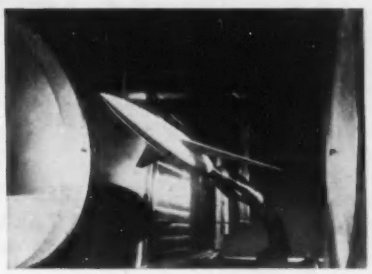
▶ Seems as if this unique stuff should be good for a *lot* of things, but *what* (other than electrical and laboratorial) probably lies in the laps of imaginative designers. Would you like us to send you a little strip to play with?

***Two tons—on the nose!*** If you called for them, we could, with reasonable speed, provide you with a king-size pair of glasses. The lenses alone would weigh in at a hefty two tons.

Since it's no mean feat to balance "specs" like that on your nose, we don't have too much call for them. Still, we have filled one order and are prepared to fill another any time they're needed. You might be interested in this little story, not as a prospect for such outsized eye-wear, but because it might suggest a new approach to some design or manufacturing problem of your own.

Our aerodynamic friends find wind tunnels valuable instruments in developing new and better products. Naturally, to make the most of said wind tunnels, it's necessary to see and photograph what's going on inside. That's what led us to build the windows you see in the picture below. Weighing nearly a ton each, these giant disks are of finest optical quality—a very necessary feature since the scientists and engineers must make precise observations through them. More remarkable still is the fact that these optically perfect pieces of glass withstand the enormous forces built up by air moving at nearly *twice the speed of sound.*

▶ If heretofore you've looked on glass as a somewhat fragile material of limited use, these windows to the supersonic world may give you food for thought. However, we like to admit that, despite the unique quality of these panes, they are just one of countless special-application products devised by Corning engineers working with customers' problem children. So, even if aeroplanes or ranting winds aren't your responsibility, talking over *your* problem with the men at Corning could very well lead to a profitable solution.



***In defense of light.*** Throwing light on a subject is often easy—*keeping* it there may be something else again.

A good, if unusual, case in point is made by a manufacturer of our acquaintance who makes shot blasting equipment for cleaning metal castings. Unfortunately the shot which cleaned the castings also played havoc with the light bulbs in the equipment. For a while it looked like a choice between constantly replacing shattered bulbs or working in the dark—neither offering a satisfactory solution.

The big question—could the castings be cleaned while being seen? Turns out the answer was YES. Corning was able to develop a special glass globe to shield the light bulbs from the metallic barrage. Made of clean PYREX brand glass No. 7740, these half-inch thick, abrasion-resistant globes let through plenty of light and, by saving bulbs from speedy annihilation, earn their keep over and over again.

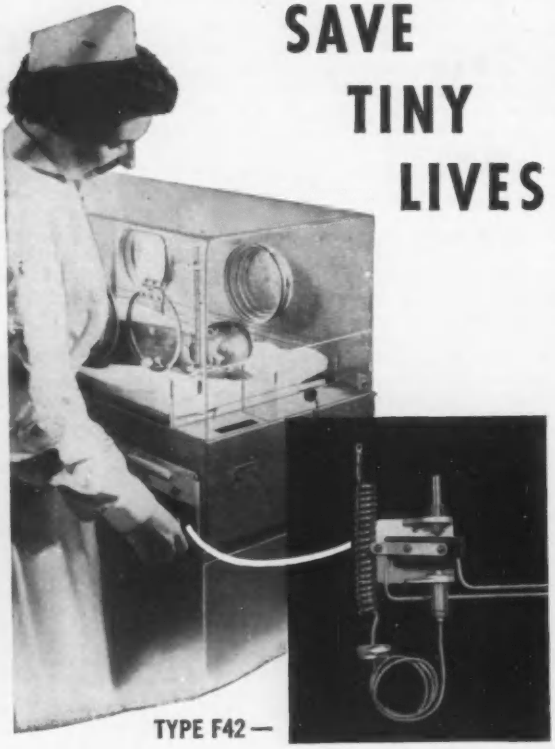
▶ If by chance some production problem centers your interest on protecting light bulbs perhaps we have the specifications, solution and can quote prices. On the other hand, if our little story serves only to give you an idea of what a rugged material glass really can be, we encourage you to refresh your memory on some of its other useful attributes, which you will find described quite lucidly in our Bulletin IZ-1, "Glass—its increasing importance in product design." We'd be delighted to send you a copy.

**Frankly, we're being amazed continually (almost) by the ingeniousness of people who come up with ideas we'd never in all time think of for putting glass to work. We've worked with hundreds of folks and we'd like to work with you, if you have a stubborn materials problem that glass might eliminate. We've got research experience, application experience, production experience, and plenty of facilities. It'd be a pleasure to put them to work for you on any likely problem or product.**

*Corning means research in Glass*

**CORNING GLASS WORKS** 11-8 Crystal St., Corning, N. Y.

# UE TEMPERATURE CONTROLS ... HELP ISOLETTE® INCUBATORS SAVE TINY LIVES



TYPE F42 —

UE controls are used in many notable applications — but none serves a more vital function than the Type F42 Thermostat now being used in Isolette Infant Incubators.

Isolette incubators feature extremely uniform air conditioning with or without added oxygen. With a basic sensitivity of ±1°F within the operating range of 75–100°F, the F42 enables these units to maintain a maximum temperature difference across the mattress of ±2°F surpassing Children's Bureau Specifications. The Type F42 achieves this control by switching on or off a 250 watt heating element located in a passage of the air circulation system.

United Electric manufactures a wide line of standard controls. They are being used for controlling aircraft fuel purging systems, paper mill machinery, diesel engines, milk pasteurizers and room air conditioners. And these are but a few of the hundreds of different industrial and domestic applications where UE controls are on the job.

Special controls can either be adapted from standard models, or they can be custom-built by United engineers working in cooperation with your own product development engineers.

For additional information on the Type F42 — or the complete line of United Electric controls and their countless applications — write:

® Registered trademark. Air-Shields, Inc.

*Standard and special thermostats and pressure switches*

**UNITED ELECTRIC CONTROLS CO.**

*87 School Street, Watertown, Mass.*

**TAKE IT FROM . . . WEMPY**

**THE KING OF NUTS**

Special nuts, custom made, to your exact specifications is my business. Whether you require steel, brass, stainless steel or aluminum, regardless of capacity (we even make 5/32" hexagon miniature nuts) you always get *uniformity, dependability,* and the *quickest service* when you deal with us.

And remember this: You'll probably pay no more for our *special fasteners* than you are now paying for ready-made standard nuts.

**Write Dept. B for Illustrative Catalog**

Be Nut Wise call on WEMPY for any size.

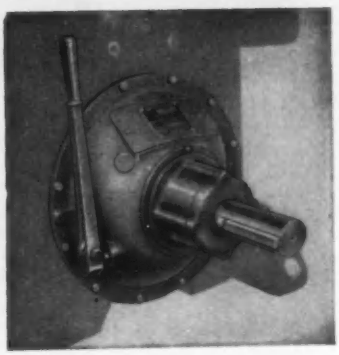
**WESTFIELD METAL PRODUCTS CO., INC.**

WESTFIELD, MASS.

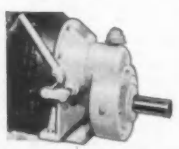
# FUNK

## POWER TAKE-OFFS and GEAR REDUCTION POWER TAKE-OFFS

For Industry & Agriculture



**. . . are available with over-center clutches for all engines with SAE flywheel housings. Gear reduction units feature exclusive straddle mounted pinions; special ratios and special adaptations of standard units. Immediate delivery. Write for catalog and prices.**



FUNK GEAR REDUCTION POWER TAKE-OFFS —with exclusive Straddle Mounted Pinion — extends life—prevents trouble. Immediate delivery.

Funk Products Include:

**Right Angle Take-Offs.**

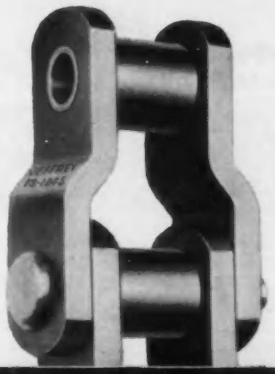
**Torque Converters**

**Power Accumulators**

**Ford Tractor Conversion Kit Changes to 6 cyl. Ford engine, doubles power and uses.**

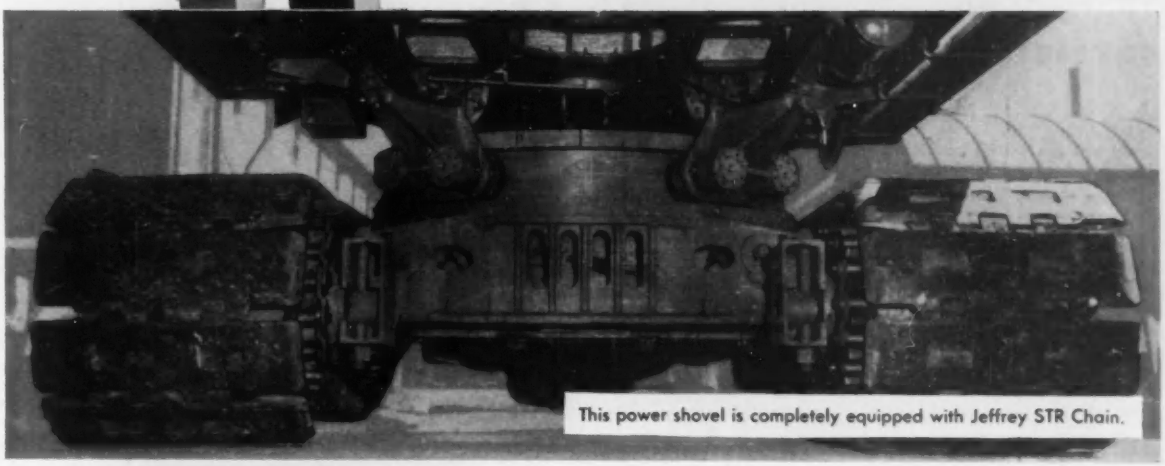
**FUNK AIRCRAFT CO.**

**3301 Airport Drive Coffeyville, Kan.**

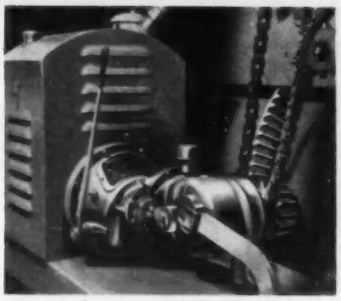


*Engineers' choice:*

# JEFFREY drive chain quality makes good equipment better



This power shovel is completely equipped with Jeffrey STR Chain.



Heavy duty concrete mixer uses Jeffrey STR Chain.

**JEFFREY COMPONENTS FOR ORIGINAL EQUIPMENT:**

- STR DRIVE CHAINS
- STEEL CARVE SPROCKETS
- HOLLOW PIN CHAINS
- CAST IRON SPROCKETS
- STEEL KNUCKLE CHAINS
- BABBITTED PILLOW BLOCKS
- COMBINATION CHAINS
- SPIRAL CONVEYORS

Equipment manufacturers from coast to coast rely on Jeffrey STR chain for flexible transmission of power in large and small unit machines such as power shovels, draglines, road pavers, ditchers, concrete mixers, garbage trucks, dredges and portable loading machines.

STR chain, in pitches of 1½" to 7", is ideal for drives on conveyors, elevators, machine tools, etc. Longer pitches, combined with attachments, are adapted to heavy duty elevating and conveying service.

If your equipment can use the superb quality of Jeffrey STR Drive Chain and Sprockets—you'll find they offer maximum strength for minimum weight, with ample reserve strength to permit normal wear and to withstand unexpected overloads.

**THE JEFFREY MANUFACTURING CO.**

ESTABLISHED 1877

Columbus 16, Ohio

*sales offices and distributors in principal cities*

PLANTS IN CANADA, ENGLAND, SOUTH AFRICA

**IF IT'S MINED, PROCESSED OR MOVED**

***. . .IT'S A JOB FOR JEFFREY!***

# FREE to Design, Plant, and Safety Engineers

## A NEW, COMPLETE REFERENCE FILE OF BARKSDALE HYDRAULIC and PNEUMATIC CONTROLS

It includes important general information such as a detailed description and illustration of the Shear-Seal principle, the only new valving principle in centuries; covers manual and solenoid valves.

It contains a simplified chart for pressure switch selection, which sheds new light on a subject shrouded in mystery.

It presents the only line of solenoid-pilot valves for air and low pressure liquid with a guarantee for longer solenoid and valve life.

Down to the handy pop-up tab, nothing has been overlooked in providing a more useful reference to the design engineer concerned with hydraulic components.

Use the coupon below to get your *free* copy of this valuable information, indispensible to modern hydraulic control.

**BARKSDALE VALVES**

5125 ALCOA AVE., LOS ANGELES 58, CALIF.

Please send a copy of the above described *Free* catalog 4G.

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

# USE EASY-IN EASY-OUT... SpirOlox

## Retaining Rings with compact 2 turn design

Eliminates trouble spots, costly machining and awkward parts!

Application pictures below show how simply and effectively cylindrical assemblies are positioned and locked by Spirolox! Unique *two-turn* design conforms to internal or external groove. Spirolox will not jump out because opening and closing force is resisted by friction between turns. Always provides a uniform shoulder! No gaps to interrupt uniform circumference; no lugs to create weak spots. Easy to flip out with screwdriver.

**FREE TEST SAMPLES AND DATA BULLETIN**

Send us blueprint of your retaining problem!

Ramsey Corporation, St. Louis 8, Mo.

A subsidiary of Thompson Products, Inc.

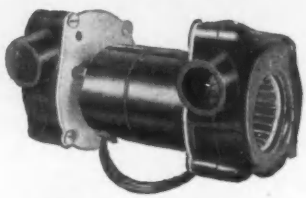
SEE OUR CATALOG IN SWEETS FOR PRODUCT DESIGNERS

67G2R

*U. S. Pat. No. 2,450,425 and Foreign Pats. Other Pats. Pend.*

**SPIROLOX—the Better Way to Hold Moving Parts TOGETHER!**

# HEINZE BLOWERS



## Type F Blowers

Originally designed for cooling electronic tubes in transmitters, induction heaters and diathermy equipment, Heinze F 2 Blowers have become popular also for advertising displays and similar applications where a small current of air and quiet operation are required.

Characterized by low wattage, neat appearance and light weight. The shaded pole motor will not cause radio interference.

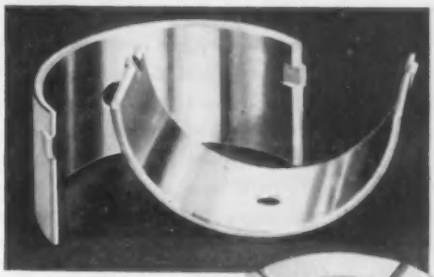
115v AC 60 cycles 15 watts
F2D (double) 20 CFM 3000 RMP (free air)
F2S (single) 10 CFM. 3000 RPM (free air)

**Heinze Electric Co**

685 Lawrence Street, LOWELL, MASS

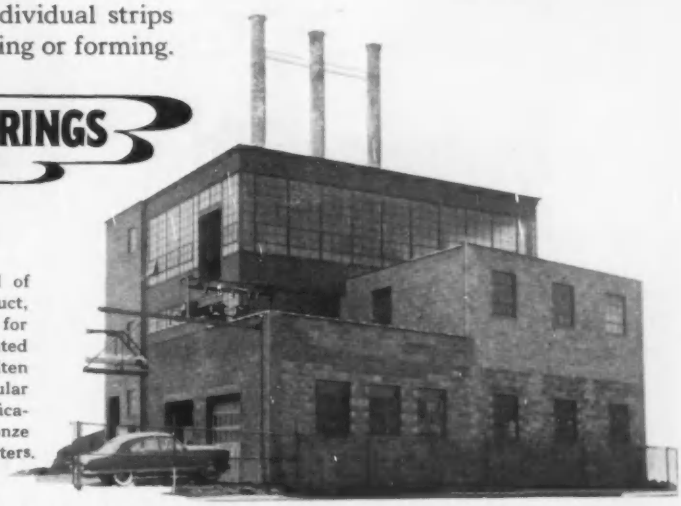
**JOHNSON**
**BRONZE·ON·STEEL**

# BOTH SURFACES



Where "two-side" bearing surfaces are required, Johnson Bronze-on-Steel is the answer. Floating connecting rod bearings often require this type of metal, also thrust washers. They are produced by bonding pre-cast bronze powder* to both sides of steel strip. This combines the fine bearing properties of copper-lead alloy with the strength and other properties of steel. This material is available in bearing form, or in strip form—rolls up to 400 feet or individual strips of any length for your own stamping or forming.

**JOHNSON JB BEARINGS**
*Sleeve-Type*



* To assure complete laboratory control of quality from the ingot to the finished product, Johnson Bronze has built a new powder plant for the production of alloy type powders by a patented process of disintegrating and quenching molten alloys. Therefore, the correct alloy for a particular use can always be prepared to correct specifications. This is another reason why Johnson Bronze has become known as Sleeve Bearing Headquarters.

Write for information.

**JOHNSON BRONZE COMPANY • 508 South Mill Street, New Castle, Pa.**

# GET THE FACTS ABOUT CARBON

(Free on request. Mail coupon.)

## Morganite Brochure Contains Many Facts Every Design Engineer Should Know About

# CARBON

Many design engineers have cracked some mighty tough problems through the use of carbon parts in machine design. Years of study have revealed properties inherent in carbon which, when applied to industrial machines, simplify design, reduce maintenance costs, and add life to vital equipment.

Carbon will withstand high temperatures and thermal shock. It will not gum up or warp under most conditions. It resists most acids, solvents, or alkalis. And it "oils" itself.

**Write Today For**

Morganite Design Data Reference—describes advantages, lists chemical and physical properties, gives hints on design. No obligation.

REGISTERED TRADE MARK

**Morganite** INCORPORATED

**3306 48th Avenue, Long Island City 1, N. Y.**

Gentlemen:
Please send me, without obligation, a copy of Morganite's new brochure, DESIGN DATA REFERENCE.

Name_____

Title_____

Company_____

Street_____

City_____ State_____

# DESIGN FOR SHORTER DOWN TIME WITH

BW Write for our latest bulletin that shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS, with diagrams of unique applications, capacity tables, dimensions and specifications.

ROCKFORD CLUTCHES are thoroughly tested to make sure they will stand up under full torque, shock-load, engagement frequency and duration, slippage and reversals, to help insure more work-time, with less down-time from machines in which they are used. Because of this exacting to-the-job-application, down-time for clutch adjustments or repairs has been reduced to a minimum. Let ROCKFORD engineers help get more work-time for your machines.

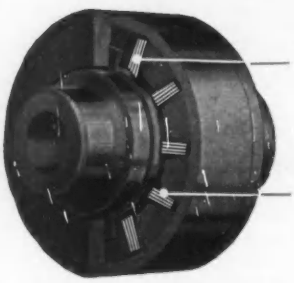
**ROCKFORD CLUTCH DIVISION**
BORG-WARNER
209 Catherine Street, Rockford, Illinois

# ROCKFORD CLUTCHES

## HERE'S WHY

**KUSHION-TORQ**

## LENGTHENS EQUIPMENT LIFE



Laminated Kantilever Steel Springs transmit driving action.

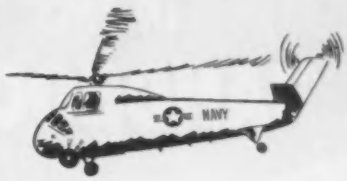
Tapered slots move point of driving contact inward as loads increase to automatically stiffen kantilevers.

These Brown Coupling features mean equipment is shock and load protected - - - coupling failure is reduced - - - misalignment is corrected - - - radial and torsional vibration are dampened - - - both drive and driven units last longer.

**For complete information shown in Bulletin 28P, write Brown Engineering Co., 108 N. 3rd St., Reading, Pa.**

**BROWN** KUSHION-TORQ **COUPLINGS**

# Why do most types of 'copters fly with Lycoming-built engines?

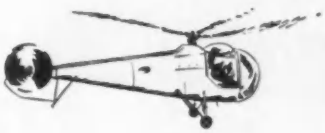



*Lycoming-powered* Sikorsky S-58*
*Anti-Submarine 'Copter*

*Lycoming-powered* Piasecki H-21*
*Materiel and Troop Transport*

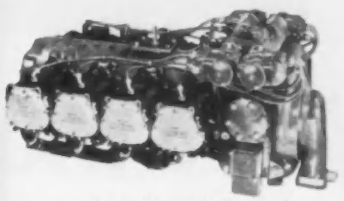
*Lycoming-powered Kaman HTK-1*
*Military Trainer*

*Lycoming-powered Doman L-Z5*
*General Utility 'Copter*

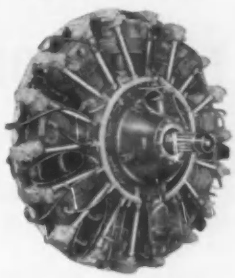


*Lycoming-powered Brantly Model B-2*
*Personal 2-place 'Copter*

*Lycoming-powered Glenview FlyRide*
*Personal 2-place 'Copter*



*4-, 6-, and 8-cylinder opposed air-cooled engines.*



*7- and 9-cylinder radial air-cooled engines.**

**LYCOMING TURBINE ENGINES**

**Still "under wraps," being developed for the Military. Lycoming's new "pioneers" that promise greater efficiency, greater economy, more brilliant performance than any helicopter engines ever before developed.**

*Wright-Cyclone engine, built by Lycoming under license from Curtiss-Wright Corporation, Wright Aeronautical Division.

The answer is simple: Lycoming builds more types of power plants designed for varied types of helicopters than any other engine manufacturer. Some users are shown above.

Since 1940—when Lycoming powered the pioneering Vought-Sikorsky 300—Lycoming has produced engines ranging from 135 to 1500 horsepower. And they have been designed for horizontal, angular, and vertical mounting.

If your problem is air-cooled power . . . precision parts . . . volume fabrication . . . or "just an idea" in the rough or blueprint stage that needs development . . . *look to Lycoming*. Long famous for metal-working skills, Lycoming meets the toughest specifications of exacting customers, both industrial and military.

FOR RESEARCH • FOR PRECISION PRODUCTION

**LOOK TO Lycoming**

DIVISION OF AVCO MANUFACTURING CORPORATION

STRATFORD, CONN., Manufacturing plants in Stratford, Conn. and Williamsport, Pa.

AIR-COOLED ENGINES • PRECISION PARTS • TURBINE RESEARCH & DEVELOPMENT

IN THIS
HANDBOOK...

100 WAYS
to Improve
Your Products

Learn how to make your products lighter, smaller, stronger, more corrosion resistant, more heat resistant, and more attractive with Alloy Metal Wire, Rod and Strip.

Send today for this new Handbook. Contains 40 well-illustrated pages of useful design information, engineering data and application studies on our Nickel Alloys.

ALLOY METAL WIRE DIVISION
H. K. PORTER COMPANY, INC.
of Pittsburgh
PROSPECT PARK, PENNSYLVANIA
"Quality Products since 1919" 1A

A NAME TO DEPEND ON BARR
FOR CUSTOM RUBBER MOLDING

Sponge, solid, extruded, and bonded-to-metal parts molded in natural, reclaimed, and synthetic rubber to your specifications.

Specialists in color molding.

*Send us your requirements for a prompt, cost-saving proposal.*

The BARR RUBBER PRODUCTS CO.
SANDUSKY, OHIO, U.S.A.
NEW YORK OFFICE: 200 FIFTH AVE., NEW YORK 10, N.Y.

TAILORED for the
APPLIANCE INDUSTRY

The CUYAHOGA SPRING Co.
SUBSIDIARY OF THE BARIUM STEEL CORP
10254 BEREA ROAD • CLEVELAND 2, OHIO

## *"6,000 employees . . ."*

**A. W. STEUDEL**
*President*
*Sherwin-Williams Company*

***"Naturally, we of Sherwin-Williams give complete endorsement to the Payroll Savings Plan. But we feel that mere approval of a national thrift movement that contributes so much to the personal security of our employees and the economic stability of our country is not enough. In our continuing effort to build employee participation in our Plan, we utilize the personal contacts and enthusiasm of our enrolled Payroll Savers. A recent person-to-person canvass by our employees put a Payroll Savings application blank in the hands of every man and woman in our plants and offices. The result, nearly 6,000 serious savers were added to our Payroll Savings Plan."***

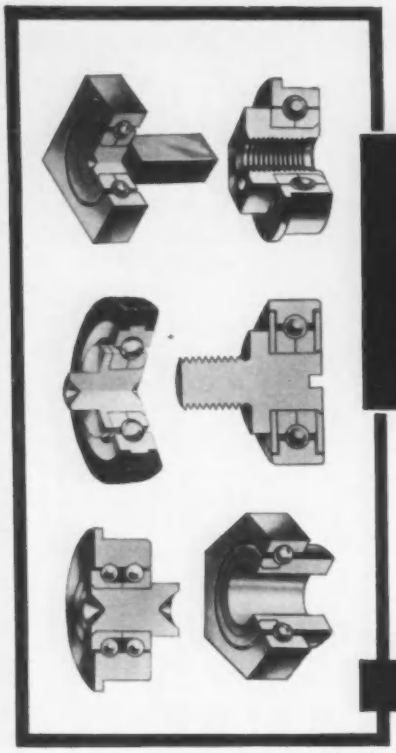
The personal interest of executives like Mr. Steudel, and the systematic bond purchases of more than 8,000,000 enrolled Payroll Savers are reflected in the following figures:

- In March, 1954, purchases of U.S. Savings Bonds, Series E and H, by *individuals* reached $474 million, highest March figure in 9 years—a gain of 20% over March, 1953.
- Purchases of E and H Bonds, by *individuals* during the first quarter of 1954, totaled $1,380 million—the highest for any quarter since 1945.
- The *cash value* of Series E and H Bonds held by *individuals* at the end of March, 1954, was $37 billion, 175 million—the highest in the thirteen year history of the Savings Bond program.
- Payroll Savers are serious savers: over 75% of the amount of Series E Bonds that matured since May, 1951—almost $9 billion—is still being held by individuals under the Treasury's 10 year optional automatic extension plan.
- For the third straight month of 1954, sales of E and H Bonds exceeded maturities and redemptions. The sales excess amounted to $242 million on March 31—the highest first quarter net since 1950.

If employee participation in your Payroll Savings Plan is less than 50%—or if your company does not have a Payroll Savings Plan, get in touch with Savings Bonds Division, U.S. Treasury Department, Washington, D.C. Your State Director, U.S. Treasury Department, will be glad to help you install a Plan and build employee participation.

*The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and*

**Product Engineering**



## UNGROUND
# BALL BEARINGS
For All Industries
# KILIAN

Long life and service are assured you because —

1. All component parts are machined from steel bars.
2. Each component part is properly heat treated.
3. Every Kilian Bearing is designed for a specific application.

Neoprene and Nylon tired outer races are available where quiet operation is desired.

**Distributors in All Principal Cities** ***Catalog on Request***

**KILIAN MANUFACTURING CORP.**

**SYRACUSE, NEW YORK, U. S. A.**

ASSOCIATED COMPANIES:
Kilian Manufacturing Corp. (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont.
Fischer Bearings (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont.
Kilian Steel Ball Corporation 100 Wellington St., Hartford, Conn.

MAYLINE

STANDARD DRAWING TABLE

FOR
**The Very Best**
IN
**Drafting Furniture**
***specify* MAYLINE**

At the ASTE show you saw these fine Mayline tables. Their prices pleased you. Your local dealer can help you choose the right table.

4-POST TABLE WITH DRAWERS

V-MODEL TABLE WITH FOOTREST

**MAYLINE CO.**
*formerly*
ENGINEERING MFG. CO.
605 No. Commerce St.
Sheboygan, Wisconsin

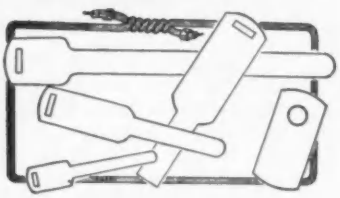
MAYLINE MAYLINE MAYLINE

**TERMINAL TAGS**

## Identify Wires Permanently

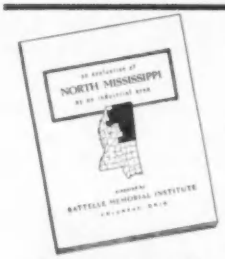
**Easy to apply, replaces obsolete string and paper identification methods. Can be specially stamp-coded or marked.**

- Aluminum, steel, brass, or zinc.
- Big variety, all styles and sizes.
- For aircraft, radio, telephone, motor and generator manufacture, etc.



*Free Samples and Literature Upon Request*

**NATIONAL BAND & TAG CO., Dept. 9-838, Newport, Ky.**




DETAILED, UNBIASED

## BATTELLE
MEMORIAL INSTITUTE OF COLUMBUS, OHIO

## REPORT
ON THE ADVANTAGES OF

## NORTH MISSISSIPPI

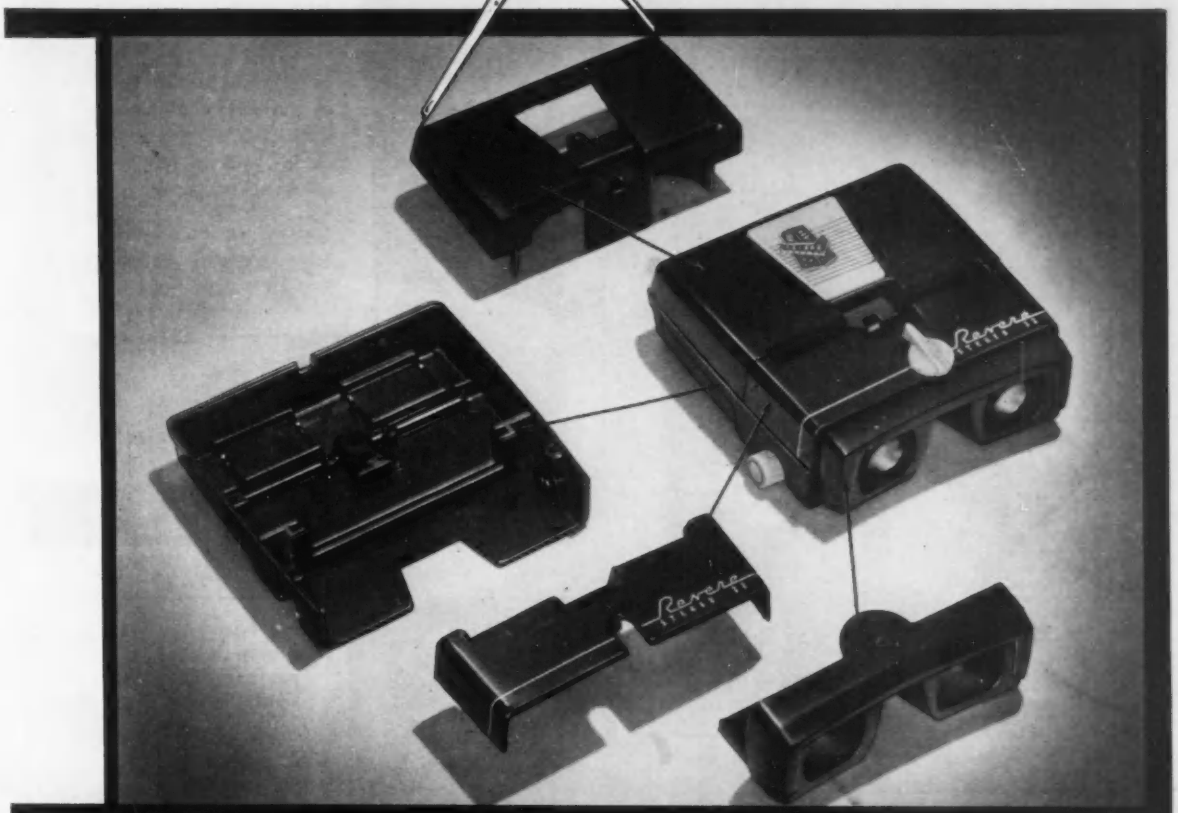
for new and expanding industries in the MACHINERY AND FABRICATED METAL PRODUCTS FIELDS. For a free copy of this new 40-page illustrated report, write on your letterhead to:

**NORTH MISSISSIPPI INDUSTRIAL DEVELOPMENT ASSOCIATION**
West Point, Mississippi P. O. Box 337E
Harry W. Clark, Executive Director

REVERE STEREO VIEWER . . .

# precision molded

IN VOLUME PRODUCTION




by RICHARDSON

**SIX PLANTS**

This handsome plastic case for the Revere Stereo Viewer, produced by Richardson, required the molding of four intricate parts. Each part had to be held to close tolerances for easy assembly and good appearance. Special care was needed to prevent warpage, and also to produce a smooth lustrous surface. The Revere Camera Company was extremely pleased with the precision and beauty of the finished job.

Richardson specializes in plastics jobs of this type—jobs which require volume production of precision moldings of the highest quality. Why don't you consult Richardson on your difficult plastics jobs?

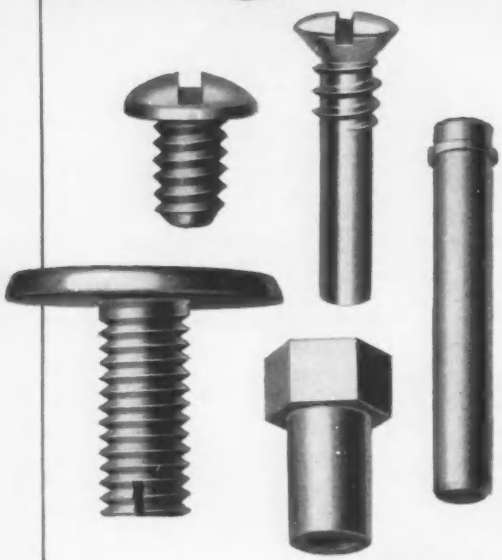
**Send for Bulletin, "Facts About Plastics"**

*The* RICHARDSON COMPANY

**2793-A Lake Street, Melrose Park, Illinois (Chicago District)**

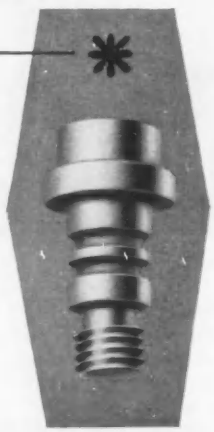
ELCO

*Specials



FOR EXAMPLE

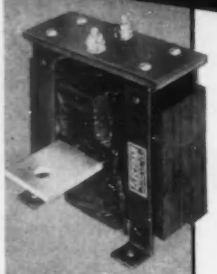
This stainless steel part was formerly made by another method of manufacturing. By using the Cold Heading method to produce this part, a savings of $46.15 per thousand was realized by the customer.

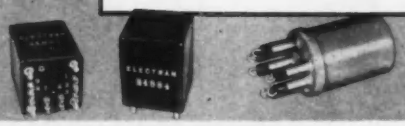


OVER 30 YEARS EXPERIENCE MAKING SPECIALS AND STANDARDS

ELCO TOOL AND SCREW CORPORATION
1958 BROADWAY • ROCKFORD, ILLINOIS

ELECTRAN Transformers





Transformers, Saturable Reactors, Chokes, Special Windings and Electronic Devices. Milliwatts to 50 KVA, single or polyphase in all frequencies.

*Complete* design and engineering service. All modern techniques, encapsulation, casting, military and commercial construction.

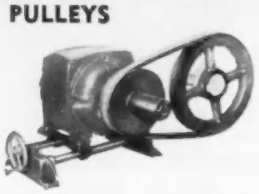
And, we've got one asset you'll find especially helpful: WE *TRY* HARDER!

*Write for Bulletin 53E*

ELECTRAN MFG. CO.
1901 CLYBOURN AVENUE • CHICAGO 14, ILLINOIS

increase machine performance with

LOVEJOY Variable Speed PULLEYS



Quickly, easily installed on old or new machines . . . allowing infinitely variable speed adjustments over wide range. A mere turn of hand instantly, accurately speeds up or slows down the driven unit for *changes in production schedules . . . adjustment for operator ability . . . corrections for size or density of stock, temperature or humidity.*

*Available in 8 sizes—fractional to 10 hp. with ratios to 3 to 1.*

Write today for illustrated catalog and complete technical data.

LOVEJOY FLEXIBLE COUPLING CO.
4873 W. LAKE STREET CHICAGO 44, ILLINOIS

ALSO MFRS. OF UNIVERSAL JOINTS AND FLEXIBLE COUPLINGS

# MORE THAN 300 LEADING MANUFACTURERS

**are already putting**

# SKF TYPE "C" BEARINGS

**in their products**

Here are the trade marks of a few of more than 300 leading manufacturers — companies who want extra bearing performance — who already are using the *improved* SKF Type "C" Spherical Roller Bearing announced less than a year ago.

There are two reasons why

First: They know that for over 40 years, SKF has been *first* with anti-friction developments that *work*.

Second: They obtain, size for size, up to 50% more capacity, 2 to 3½ times increased life with SKF's Type "C" Spherical than they can obtain with any other available design, and at no increase in cost.

7550

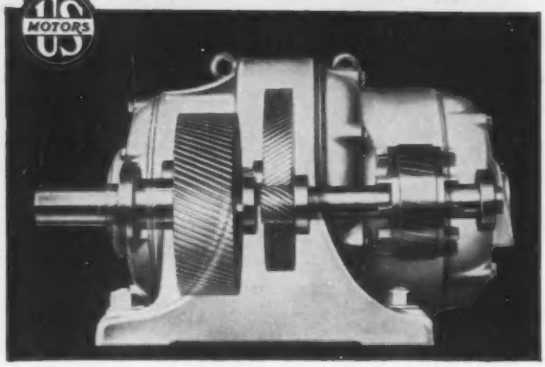
**SKF** INDUSTRIES, INC., PHILADELPHIA 32, PA.
*— manufacturers of* **SKF** *and* HESS-BRIGHT® *bearings.*

©1954 — SKF Industries, Inc.

**SKF®**

**BALL AND ROLLER BEARINGS**

# Geared Power
SIMPLIFIED WITH
# SYNCROGEAR




***The motor that internally gears its speed***

DON'T go to the expense of installing a gear box with extra coupling and guards to rig up slow speed for a motor. Install the *U.S. Syncrogear motor* and avoid extra contraptions. You'll simplify your power hook-up, save space, eliminate hazards and give your driven machine the most efficient power. The U.S. Syncrogear motor was one of the first complete integral power units, introduced 22 years ago. It's backed by experience, tested and proved performance and engineering "know-how" that only U.S. MOTORS can offer to those seeking the most dependable geared motor power.

**SYNCROGEAR ADVANTAGES**

- Compact—rugged—quiet
- No external gear box
- No extra coupling
- Internally-geared
- Single unit on one base
- Completely housed
- Reduced frictional losses
- Permanently-aligned parts
- Super-hardened gears
- Pyramidal supporting base
- Solid shank pinion
- Normalized castings
- Extra large oil reservoir
- Asbestos-protected windings
- In-a-line shaft
- Neat, streamline appearance
- Drip-proof surface

**U.S. SYNCROGEAR MOTOR** 4 TO 10,000 RPM. 1/4 TO 30 H.P.

REQUEST FOR SYNCROGEAR MOTOR BOOKLET

U. S. ELECTRICAL MOTORS INC. PEN-6
Box 2058, Los Angeles 54, Calif.
or Milford, Conn.

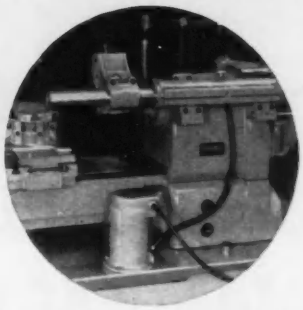
NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE___ STATE_____

RUTHMAN GUSHER COOLANT PUMPS



*This Hardinge Model HCT Chucking Machine with Production Threading Head is equipped with a Gusher Coolant Pump.*

# SOLVE YOUR COOLANT PROBLEMS

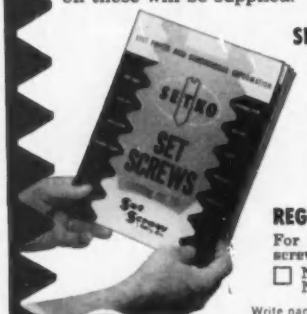
For all your coolant pump requirements, there's a type and capacity Gusher Coolant Pump to meet your every need.

You can choose between immersed type, outside mounted pipe connected, flange mounted with external or internal discharge in capacities up to 200 G.P.M.—1/30 to 2 H.P. Shaft and belt driven models also available. Write for our complete catalog.

THE RUTHMAN MACHINERY CO.
1318 READING ROAD CINCINNATI, OHIO

# FREE... Latest Data on Problem-Solving SET SCREWS

If you have puzzling set screw problems, check off below, the special type Setko Set Screws that seem to fit your need. Bulletins on these will be supplied.




**SPECIAL TYPES**

- ☐ Increased Holding Power NU-CUP Set Screws
- ☐ Hollow-Head Self-Locking IMPROVED ZIP-GRIP*
- ☐ Slotted-Head Self-Locking OFFSET Set Screws

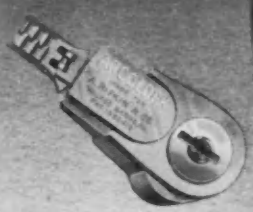
**REGULAR SET SCREWS**

For prices and general set screw data check

- ☐ New COMPLETE CATALOG No. 19.

Write name and address in the margin of page, tear out and mail. Bulletins or catalog will be sent promptly . . . no charge or obligation.

Set Screw & Mfg. Co.
*Pat. Pending
153 Main St., Bartlett, Ill. (Chicago Suburb)
We Specialize in Solving Puzzling Set Screw Problems



*Nerve center of this tamper-proof exclusive Yale-made Arcolock® lock is a small but mighty cylinder designed so that each depository bag requires its own individual key. No interchanging. Yet one master key in the hands of the bank controls all depository bags simultaneously.*

*The Rifkin Safety Sac with Arcolock made by Yale*

***NEW NIGHT DEPOSIT BAG***

**Allentown National Bank customer uses master key to open his night deposit "Safety Sac with Arcolock" while G. Winfred Baker, left, assistant cashier, looks on.**

**New zipper-top deposit bag is designed to save time lost hunting misplaced keys or padlocks and, with master key system, facilitates opening many bags at one time.**

## Unique Night Deposit System Cuts Bag-Handling Time

ALLENTOWN, Pa. — A genuine advance in night deposit control is reported by the Allentown National Bank with the initiation of a new type deposit-bag and a foolproof master key system.

Faced with the persistent problem of lost padlocks, lost keys, and time consumed locating hundreds of keys on the board, the Allentown National Bank recently installed a completely new zipper-top deposit bag and master key system which, according to the bank, saves many costly man hours.

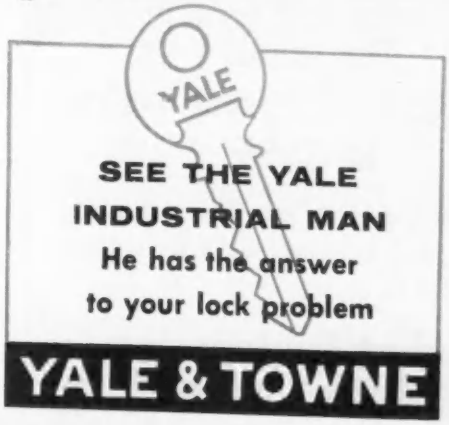
The bag, designed for night depository use, by A. Rifkin & Co., a company specializing in currency bags for banks, is called the Rifkin Safety Sac and features an exclusive Yale-made Arcolock which eliminates the annoyance of the loose padlock bag. The Arcolock is a tamper-proof integral part of the bag, which cannot be lost. It functions simply, speedily, efficiently. To lock the bag, the zipper is closed all the way and the plunger is pressed down, locking automatically. The key, itself, cannot be locked inside the bag since the Arcolock cannot be locked unless the key is in the lock. After the bag is locked, the key can be removed and kept at the customer's office, while the messenger delivers the bag to the bank.

To further expedite the system, and to cut down on man hours spent locating individual keys, the bank has carried the efficiency program a step further with the adoption of the Rifkin master key system. This enables the bank to open hundreds of bags with one master key. Each bag, however, has individual locks for customer protection.

Since the switch-over to this new type currency bag, the bank reports a substantial saving in bag-handling time, greater customer satisfaction, and actual increase in the number of night depositors. The Rifkin company, itself, reports nation-wide acceptance of its safety sacs with Arcolock.

From April 21, 1954 issue of the American Banker

# LOCK PROBLEMS?




## They don't come too tough for YALE

No company offers a wider, more versatile line of standard locks than Yale . . . but our ace-in-the-hole is a group of extremely competent industrial lock experts who are delighted to come to grips with seemingly-impossible requests for special locks.

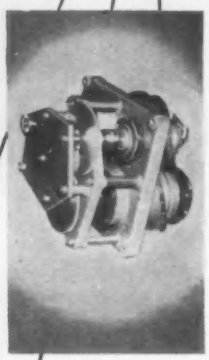
If you have a lock problem . . . make it ours by getting in touch with a Yale lock expert. There should be one in your locality now. Let him tell you, without obligation, about standard Yale locks that might suit your purpose now . . . or how we go about designing a special lock to solve your problem.

or write: INDUSTRIAL LOCK DEPT.
THE YALE & TOWNE MANUFACTURING COMPANY
Lock & Hardware Division, Stamford, Connecticut

YALE Reg. U. S. Pat. Off.

*from*
DRAWING BOARD
*to*
FINISHED PRODUCT
*under one roof!*

SERVO ANALYSIS NETWORK



ANGULAR POSITION TRANSMITTER

POTENTIOMETERS —precision linear and non-linear

GUN DIRECTOR—being optically aligned.

Serving the Armed Forces and Industry in the research, development, design and manufacture of electronic, electrical, electromechanical and mechanical devices—DAYSTROM INSTRUMENT has a full range of up-to-date equipment for production from raw materials to finished assemblies and systems. *Under one roof* their 350,000 sq. ft. plant has facilities available to meet every need for internal, external, surface and centerless grinding; low to high precision turning; jig boring and milling; welding, heat treating and finishing; spur and helical gear shaping; hobbing and shaving; straight and spiral bevel gearing; test and inspection, facilities and know-how for the entire range of production.

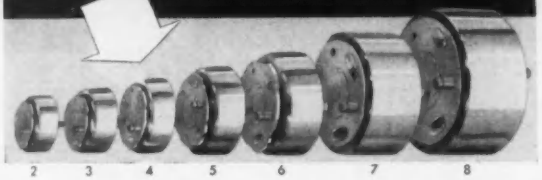
*Division of Daystrom, Incorporated*

**DAYSTROM INSTRUMENT**

ARCHBALD, PENNSYLVANIA

AFFILIATES:
American Type Founders, Elizabeth, N. J.
Daystrom Furniture Div., Olean, N.Y.
Daystrom Electric Corporation
Poughkeepsie, N.Y.

**NEW MODEL NO. BD4**
**LEDEX ROTARY SOLENOID**
**gives snap-action torque!**




Now, with the addition of the new model BD4, Ledex Rotary Solenoids are available in seven basic sizes with various degrees of rotation and torque values up to 54 pound-inches. This new BD4 model offers the same compactness, ruggedness, versatility and dependable snap action as all the previously available sizes of Ledex.

*Torque values for normal intermittent duty and 45° stroke.*

| Model No. | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| Diameter inches | 1 1/8 | 1 5/16 | 1 9/16 | 1 7/8 | 2 1/4 | 2 3/4 | 3 3/8 |
| Torque lbs.-inches | .4 | 1.0 | 1.7 | 4.0 | 7.5 | 25.0 | 54.0 |

WRITE FOR DESCRIPTIVE DATA TODAY!

**G. H. LELAND, INC.**

123 WEBSTER ST., DAYTON 2, OHIO

***Why SCHNORR Disc Springs?***

BECAUSE

1. Unlimited life within borders of permissible loads.
2. No creeping, initial settling or gradual fatigue.
3. Axial center pressure.
4. Exact adjustment to the desired pressure.
5. Small constructional height, large deflection.
6. Large inherent damping.
7. Large impact damping especially with multiple stacking.
8. Excellent space disposition.
9. Spring pressure, Spring length and Spring deflection can be easily determined for the same Spring size or can be changed by lengthening or shortening of the Spring columns or by multiple stacking. In special cases the character line can be made to divert from its usual form by diversified stacking.
10. Most Spring sizes available from stock.

*For Descriptive Literature Write*

**KARL A. NEISE,** Dept PE
404 Fourth Avenue, New York 16, N. Y.

**The Annual**
**HANDBOOK of Product Design for 1955**

will be ready in October. This widely acclaimed service is part of your regular subscription to . . .

**Product Engineering**
McGraw-Hill Building New York 36, N. Y.

# ONE *minute from now . . .*

# FOUR *more Americans will need blood . . . urgently!*

Every 60 seconds of every year FOUR Americans are injured seriously . . . so seriously that their lives depend on immediate transfusions.

Startling? Yes, but serious injuries are only one of the reasons why blood is needed *constantly*. Every day thousands of men, women and children MUST have blood for medical and surgical treatment.

In addition, we must continue to build a national reserve of blood as insurance against future disasters and emergencies.

You can help supply the blood that America needs constantly . . .

**NATIONAL BLOOD PROGRAM**

*the blood you give helps someone live!*

# GIVE BLOOD NOW

# MESSAGE TO AN ENGINEER THINKING ABOUT THE FUTURE— HIS FUTURE

Take a few moments now to review the progress of your career. Does your present position offer you a future that fully utilizes your creative abilities?

Compare your present assignment with the diversified, stimulating pursuits that increase the inventive challenge of Fairchild's team of qualified engineers. These men are working on engineering advances for the famous C-119 Flying Boxcar and the soon-to-be-produced C-123 Assault Transport. More than that, they are developing tomorrow's jet fighters . . . special reconnaisance aircraft . . . jet bombers and transports. The men at Fairchild know that *planned* project diversification keeps them in the forefront of the field of aerodynamics.

Gracious country living only minutes away from urban Baltimore or Washington . . . paid pension plan . . . an excellent salary with paid vacations . . . ideal working environment . . . generous health, hospitalization and life insurance . . . and the many other benefits of a progressive company add to the pleasure of working with Fairchild.

You'll be investing wisely in a secure future if you take time today to write to Walter Tydon, Chief Engineer, outlining your qualifications. Your correspondence will be kept in strict confidence, of course.

ENGINE AND AIRPLANE CORPORATION
**FAIRCHILD**
*Aircraft Division*
HAGERSTOWN, MARYLAND



## OIL HYDRAULIC POWER and its INDUSTRIAL APPLICATIONS

**You'll find this guide a valuable working** tool covering accepted practices in oil hydraulics—development, theory, and practical applications. Discusses generation of oil hydraulic power . . . its use in rotary and reciprocating motors . . . its control by suitable valves . . . its transmission through piping, tubing and fittings. **By Walter Ernst, Hydraulic Consulting Engineer. 366 pp., 275 illus., $8.00**

## PRACTICAL GEAR DESIGN

*Just Published!*

**Shows methods of calculation of load-carrying capacity of gears.** Proper geometric proportioning of parts, choice of materials, sizing of parts for manufacturing processes, service conditions, and kinds and causes of failure. Gives many equations, curve sheets, and tables to aid in design of commonly used types of gears. **By Darle W. Dudley. Supervisor — Gear Advance and Devel. Eng., General Electric Co., 352 pp., 165 illus. $7.00**

## ENGINEERING DRAWING

**New idea in engineering drawing manuals** . . . hundreds of drawings—in a giant, oversized format—show step-by-step all drafting techniques, constructions, projections, and use of instruments. Basic self-teacher in all fundamentals . . . ideal refresher course for technical men. Explains orthographic projection by means of "pictorials" which let you "see" the object in space. Even covers basic shop processes. **By Frank Zozzora, Head of Engr. Draw., U. of Delaware. 361 pp., 628 illus., $5.00**

## TIMESTUDY FOR COST CONTROL

*3rd Ed.—Just Published!*

**Simple, practical manual of timestudy and control based on predetermined standards, especially suited to medium and small-sized plants.** Gives step-by-step procedures, from how and where to start, to the application of data in production control. Includes such topics as analyzing timestudy results, building standard data and data work sheets, getting incentive performance and maintaining correctness in standards. Third Edition includes outline of Basic Motion Timestudy, examples of actual predetermined time standards, and alignment chart approach useful in salary evaluation. **By Phil Carroll, Prof. Eng. 3rd Ed. 329 pp., 102 illus., $5.00**

**SEE THESE BOOKS 10 DAYS FREE**

**McGraw-Hill Book Co., Inc., Dept. PE-8**
**330 W. 42 St., NYC 36**

Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents delivery, and return unwanted book(s) postpaid. (We pay delivery if you remit with this coupon—same return privilege.)

- ☐ Ernst—**Oil Hydraulics**—$8.00
- ☐ Dudley—**Practical Gear Design**—$7.00
- ☐ Zozzora—**Engineering Drawing**—$5.00
- ☐ Carroll—**Timestudy for Cost Control**—$5.00

(PRINT)
Name .....
Address .....
City .....Zone....State.....
Company .....
Position .....
**This offer applies to U. S. only.** PE-8

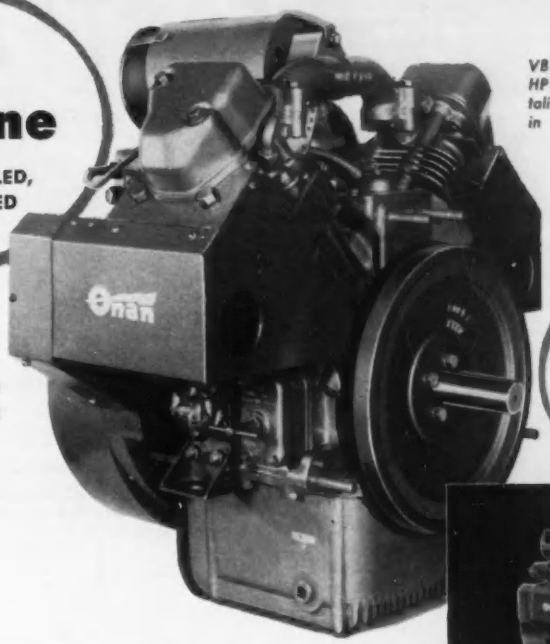
# First of their class built to military standard parts specifications!

**the ONAN**

## VB Engine

**21 H.P., AIR-COOLED, GASOLINE POWERED**

*VB engine qualifies to MIL-E-11275A, 10 HP Class on standardization of high mortality parts. Generator designed and tested in accordance with MIL-G-10228 (CE).*



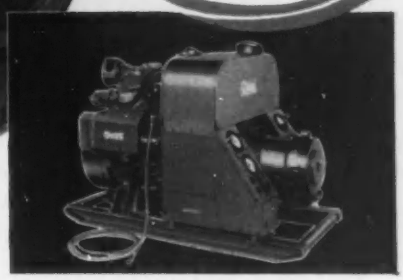

**the ONAN**

**5VB-4M Generating Set**

**5,000 watts A.C.**

**Recommended for heavy-duty use on military equipment such as:**

Construction machinery
Lift trucks
Small vehicles
Welders
Refrigerators
Air Conditioners
Compressors
Pumps



### *Give your military equipment an important competitive advantage with this NEW prime mover*

The Onan VB engine meets or exceeds all military specifications in design and construction. Proved and tested in 1,000-hour endurance runs, the Onan VB fulfills performance requirements under all specified conditions including high altitude and adverse temperatures.

At 3600 R.P.M. this new high compression, overhead-valve, two-cylinder, V-type engine develops 21 H.P. without accessories . . . delivers 19 H.P. with accessories . . . assures adequate power for scores of military prime mover applications.

Design of the suction cooling system incorporating a large centrifugal blower allows the engine to be "buried" within a large piece of equipment *in space only slightly larger than actual engine dimensions.*

Built largely of aluminum, the VB engine weighs only 140 pounds with accessories. Equipped for manual starting using integral, self-winding rope starter or for electric starting. Available with either disc drive or crankshaft extension.

To fit your equipment into the military standardization program, use the new Onan VB engine. *Let us help you plan your application.*

**The Onan Model 5VB-4M,** using the VB engine, meets all specified test requirements for Military Type II, Class A engine generator sets.

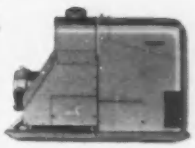
After 1,000 hours of operation with full rated load, and under test conditions of 107° F. and 5,000-foot altitude, the Model 5VB delivers *more than 150% of rated output at rated voltage, frequency and power factor.*

*The skid-mounted set has an actual dry weight of 445 pounds and requires 25% less space than many conventional units. Suction-cooled.*

*Generator supplies multiple voltages (1 and 3-phase) with voltage regulation within 4%. Rated at 5KW with 60-cycle output, this model is also available with D.C. output up to 7½ KW in standard voltages. Equipped with all essential instruments conveniently located and protected.*

**WINTERIZED MODEL**

Equipped with engine heater and rugged sheet-metal housing to protect generating set against wind, rain and snow. Weight: 500 lbs. Delivers full rated output at ambient temperatures from +125° to −65°F.



*Be the first to have your type of equipment powered by a prime mover or generating set built to military standard parts specifications. Write for complete information.*

Onan ELECTRIC PLANTS

## D. W. ONAN & SONS INC.

8990 University Avenue S.E. Minneapolis 14, Minnesota

ELECTRO SNAP

NEW ONE WAY IMPULSE SWITCH

For Simplified Control

MODEL ES4—KM2

**ELIMINATES INTERLOCKING SWITCHES AND COMPLICATED ACTUATING DOGS**
This exclusive switch is ideal for pulsing solenoid valves on air-hydraulic controls, sequencing circuits, etc., because it allows other controls to reverse or operate the same circuit. It sends a short electrical impulse and then switches itself out of the circuit.

**GIVES MORE DEPENDABLE CONTROL**
Switch replaces timers, relays, and troublesome one-way dogs to simplify circuits—cuts chances for failure. No delicate adjustments.

**LOWERS COST OF CONTROL CIRCUITS**
Impulse switch costs less than complicated control devices it replaces. Fewer switches are required for sequencing. Because of simplicity, maintenance is easy.

**SPEEDS UP AUTOMATIC OPERATION**
Automatic machines can run faster because cycles can be more closely sequenced. There's no delay due to timer tolerances or extra machine motions to actuate interlock switches.

**TRY IT NOW—WRITE FOR** DATA SHEET

**SPECIFICATIONS**

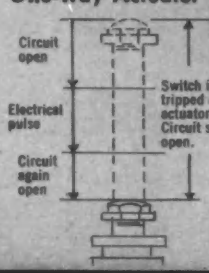
rated at 10 amps., 125/250 v. AC.

Movement differential 0.022".

Operating Force 3½ lbs.

Four models available with overtravel and pulsing strokes from 1/16" to 3/16".

**How Exclusive One-Way Actuator Works**




ELECTRO-SNAP SWITCH & MFG. COMPANY
4224 West Lake Street, Chicago 24, Illinois

here's what **DIE CAST** **GRC** ZINC ALLOY THREADED **FASTENINGS** mean to you...

in terms of a better product, in terms of a more economical product!

*Every Quality Feature is an Economy Feature!*

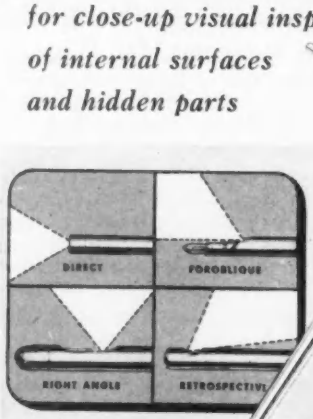
- The plain bright finish does not require further surface finishing for most applications
- Closer tolerances • Cleaner threads
- Greater dependability, durability
- Die-cast uniformity. LOWER PRICED!
- NON-FERROUS • RUST-PROOF
- CORROSION-RESISTANT

Quick deliveries from stock • Specials to order
Write today for samples, prices & bulletins

**GRIES REPRODUCER CORP.**
*World's Foremost Producer of Small Die Castings*
159 Beechwood Ave., New Rochelle, N.Y. Phone NEw Rochelle 3-8600

*A.C.M.I.* **BORESCOPES**

*for close-up visual inspection of internal surfaces and hidden parts*




*A.C.M.I. Borescopes are available in 4 angles of vision (as above)—in diameters of .120" to 4.00"—in lengths of 4" to 720". Special models for special problems.*

A.C.M.I. Borescopes permit close-up visual examination of interior areas and surfaces not otherwise visible. They save time and money, and prevent costly dismantling. • Each Borescope is a compact, self-illuminated industrial telescope of highest quality, employing a precision optical system, that produces a flat visual field. Lens systems are fully corrected for color, spherical aberrations, and coma, with all lens surfaces coated to increase light transmission

*Write for free informational folder, or tell us your problem.*

*American Cystoscope Makers, Inc.*
1241 LAFAYETTE AVENUE NEW YORK 59, N. Y.

# 7,000

## 7,000 ITEMS A KEY TO K&E LEADERSHIP

*Drafting, Reproduction, Surveying,*
*Optical Tooling Equipment and Materials*
*Slide Rules Measuring Tapes*

**• Since 1867 engineers, scientists, designers, surveyors, draftsmen have relied on K&E as the foremost, most progressive, and most complete source of supply for the tools, equipment, and materials they work with. When you buy, think first of K&E, headquarters for 7,000 items. For example . . .**

**ALBANENE® TRACING PAPER**—This popular tracing paper is recognized as the top product in its field because of its permanent transparency, its unusual strength and its superb drawing surface.

Albanene is transparentized with an inert resin, which is permanently fixed in the fibers and unaffected by age. Its outstanding tearing strength enables it to resist wear and tear in reproduction machines and in handling and filing. Its special surface combines ideal pencil "take" with clearness, sharpness and cleanness of line.

**KEUFFEL & ESSER CO.**
**New York • Hoboken, N. J.**
Chicago • St. Louis • Detroit • San Francisco • Los Angeles • Montreal
Distributors in Principal Cities

# ROTH RUBBER

**Abrasion resistant rubber paddles are easily replaced in new**

**PETTIBONE SPEEDPILER**

Whirling at 2000 feet a minute, six rubber paddles throw sand, crushed stone, coal, chemicals, feed, grain, salt, sugar, fertilizer and other bulk materials . . . wet or dry . . . 47 feet and farther. Most of this material, up to 1" in size, has a terriffic abrasion quality.

**Roth Rubber Engineers Solved This Problem**

Roth engineers specified and formulated just the right rubber to resist this tremendous abrasive action. Also solved was the problem of fast, easy, inexpensive replacement. Roth engineers can solve *your* rubber problems. There's no obligation for Roth technical assistance. Write us a description of your rubber problem or your rubber requirements. We'll be glad to help.

**Engineers and Rubber Buyers!**

Write for your free Roth Rubber Sampler. This unusual kit contains actual rubber samples with hardness from 5 to 100 Durometer . . . gives ASTM specs and lists uses for each sample. Sorry, but offer must be limited to engineers and rubber buyers only.

Please ask for Roth Rubber Sampler No. PE5.

*Custom manufacturers of Industrial Rubber Products since 1923*

**ROTH RUBBER COMPANY**

1856 S. 54TH AVENUE • CHICAGO 50



*Can*

# CARAVAN AXLES

Improve your Product?
Lower your cost?

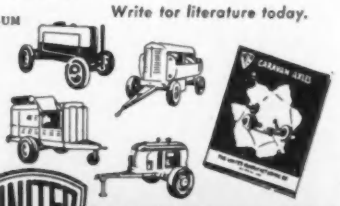
We are AXLE men . . . United's specialization in the axle field gives you the benefit of job-engineered endurance, safety, and long life . . . at lower cost.

For heavy load stability, CARAVAN Axles provide a massive heavy-duty steering arm, extra-heavy center arm stop blocks, a heavy-duty steering knuckle, and precision ground spindles which provide axles with close tolerances. Wide inside wheel turning angle assures maximum maneuverability and eliminates jack-knifing. Axle assemblies are available for two and four-wheel units up to 15,000 lbs. capacity.

For dependability and lower costs, mount your product on CARAVAN Axles.

*Write for literature today.*

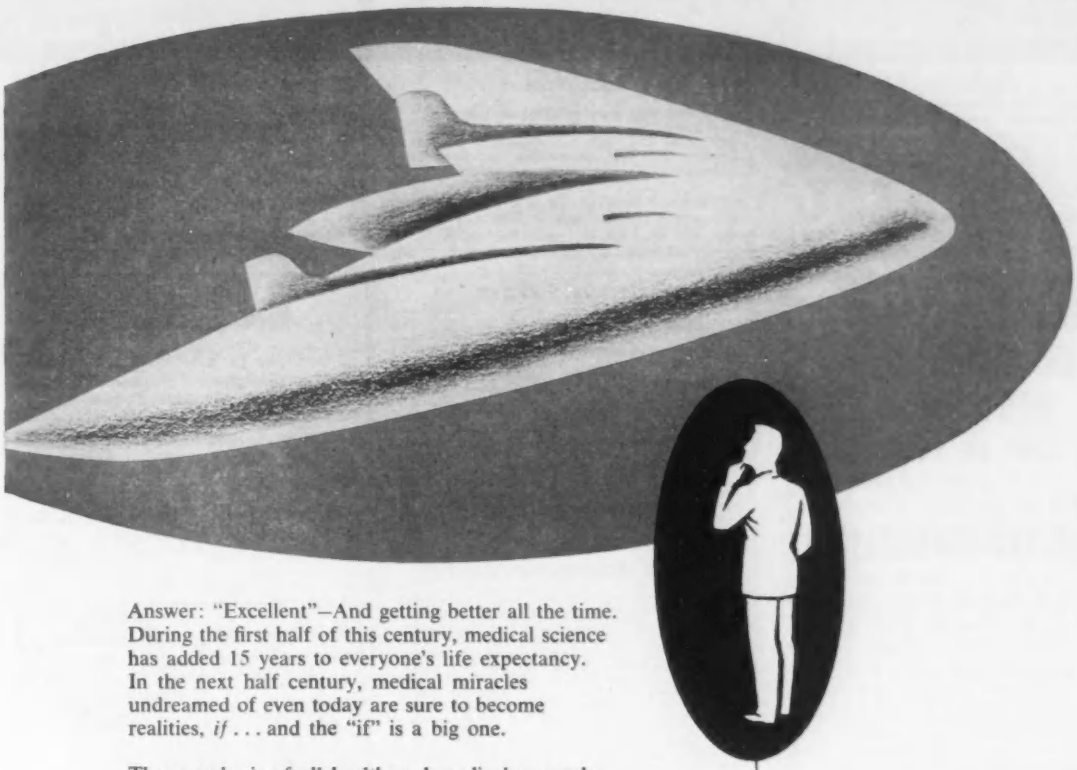
1867-UM



**UNITED MFG. COMPANY**

**821 INTERSTATE ST. • BEDFORD, OHIO**

# how are your chances of being around in 1999?



Answer: "Excellent"—And getting better all the time. During the first half of this century, medical science has added 15 years to everyone's life expectancy. In the next half century, medical miracles undreamed of even today are sure to become realities, *if* . . . and the "if" is a big one.

The very basis of all health and medical research, the foundation without which no hospital or health agency can operate, is imperiled. That foundation is the country's compact network of 79 medical schools.

The threat is real and immediate . . . the production line of well-trained doctors is seriously endangered. Lack of operating funds has reduced teaching time by 7%, created vacancies in one out of every 20 full-time teaching positions, caused three private medical schools to become state institutions within the past three years . . . and all of this at a time when demands of our expanding population and rapid scientific advances require the highest in teaching standards, and larger enrollments.

Hundreds of firms in industry have recognized this threat in its fullest implication. The contributions they are making to the National Fund constitute one of private enterprise's major services to the nation. At the same time these contributions serve as safeguards for their investments in family, community and employee health. Get full details on the crisis that faces medical education, and learn how you can help solve it.

**NATIONAL FUND FOR MEDICAL EDUCATION**

MEDICAL EDUCATION KEEPS AMERICA HEALTHY

## FACTS YOU SHOULD KNOW ABOUT MEDICAL EDUCATION

- There are only 79 accredited medical schools in the United States.
- They train 82,000 undergraduates, specialists and technicians and graduate 6,500 doctors annually.
- It costs from $10,000 to $12,000 to train a doctor today.
- Tuition fees, raised 84% over 1940, cover less than 20% of the cost.
- In the past decade medical teaching budgets have risen 143%; administration and plant operation 150%.
- The medical schools need $10,000,000 annually in additional income to maintain present standards and train the necessary number of doctors required for America's growing population.
- *ALL* 79 medical schools can be aided by a *single* gift to the National Fund for Medical Education.
- Contributions are distributed through annual grants according to a schedule approved by the medical schools.
- The National Fund is a voluntary, non-profit organization approved and supported by the American Medical Association and the Association of American Medical Colleges.

***For complete facts on the crisis facing medical education write to***

The National Fund for Medical Education,
2 West 46 Street, New York 36, New York

# CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

## EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

**UNDISPLAYED RATE**

$1.50 per line, minimum 3 lines. To figure advance payment, count 5 average words as a line.

(See ¶ on Box Numbers.)

POSITION WANTED undisplayed advertising rate is one-half of above rate, payable in advance.

PROPOSALS $1.50 a line an insertion.

**INFORMATION**

BOX NUMBERS care publication count as 1 line additional in undisplayed advertisements. DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals.)

EQUIPMENT WANTED OR FOR SALE Advertisements acceptable only in Displayed Style.

**DISPLAYED RATES**

The advertising rate is $15.10 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches —to a page. P.E.

*Send New ADVERTISEMENTS to New York Office, 330 W. 42nd St., New York 36, N. Y., for the September issue closing August 19th*


**ELECTRONIC ENGINEERS & PHYSICISTS**

YOU CAN BE SURE

of a lifetime oppty.

IF IT'S

**WESTINGHOUSE**

who is offering it!

Our Expanding Tube Division Offers Good Opportunity for Professional Progress, and a Pleasant Life, amid New York State's Resort Lake-Land ! !

**TUBE DESIGNERS:** Microwave tubes, receiving tubes and solid state devices.

**APPLICATION ENGRS.:** Circuit development exp. in radio, TV, VHF, sweep circuits.

**PRODUCTION ENGRS.:** for Color TV. Knowledge photo sensitized screens, silk screens or printed screens.

*Expenses paid for Engrs invited to Elmira for interview. Send resume:*

**WESTINGHOUSE ELEC. CORP.**

P. O. Box 284 Elmira, N. Y.


*REPLIES (Box No.): Address to office nearest you*
*NEW YORK: 330 W. 42nd St. (36)*
*CHICAGO: 520 N. Michigan Ave. (11)*
*SAN FRANCISCO: 68 Post St. (4)*

### POSITIONS VACANT

MECHANICAL ENGINEER—Young, to train in anti-friction bearing engineering and sales. Send brief history and salary desired. P-2776, Product Engineering.

DESIGN ENGINEERS, 25 to 35, mechanical engineering degree, two years' minimum design experience in heavy machinery. Creative ability and interest in professional development required for permanent employment in medium size company located in small attractive town in Ohio. Salary $4800.00 to $6000.00 plus expenses and profit participation. Opportunity for advancement. P-3246, Product Engineering.

WANTED: MECHANICAL and Electrical Engineers-Designers. We invite you to call or write for an interview. Inquiries held in confidence. Monarch Machine Tool Company, Builders of Monarch Lathes, Sidney, Ohio.

### POSITIONS WANTED

MACHINE DESIGNER — Mining and Automatic production machinery experience, age 48. Will relocate, resume on request. PW-3048, Product Engineering.

CONTROLLER OFF. 15 years every phase metal-machine shop experience, budgets, costs, personnel, systems, renegotiations. PW-3227, Product Engineering.

MECHANICAL ENGINEER BME 12 years power and maintenance experience. Supervision maintenance repair heavy equipment building construction and repair, plant layout, tooling. PW-3207, Product Engineering.

### POSITIONS WANTED

TECHNICAL REPRESENTATIVE in Los Angeles. Mechanical Engineer: Former factory owner with seventeen (17) years experience in aircraft and consumer goods design and manufacturing will represent manufacturer of product of merit. Mechanical component or machine tool preferred. Will demonstrate, supervise installation or erection and handle field service. Can provide office and small warehouse in suburban L. A. if desired. Box PW-3394, Product Engineering.

SALES ENGINEER BME 8 years industrial sales broad knowledge hydraulic and pneumatic equipment and accessories plastic processing and molding equipment. PW-3209, Product Engineering.

### SELLING OPPORTUNITY WANTED

ACCOUNTS WANTED: Experienced sales Engineer with office in Philadelphia, now calling on quantity production manufacturers, many of whom are customers, in lower New York, including New York City, New Jersey, eastern Pennsylvania, Delaware and Maryland, desires high grade small or medium sized stampings and machine screw or similar parts accounts to complement present non-competitive products. RA-2852, Product Engineering.

ESTABLISHED MANUFACTURER of custom equipment for the plastic, electronic, rubber, and textile industries in New England desires to supplement sales through representation of related mechanical items. Facilities are available for conversion, alterations, assembly, storage, distribution and service. RA-3428, Product Engineering.

### BUSINESS OPPORTUNITY

**New Product patent available, For Sale or** License—Pneumatic highway truck spring suspension and weighing system—Weber Instrument Company, 13845 Elmira, Detroit 27, Michigan.

### WANTED

ANYTHING within reason that is wanted in the field served by Product Engineering can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.


**500 PENNI-PRINTS $5**

Sell your idea with PENNI-PRINTS Drawings, Diagrams, Testimonials 8½ x 11 Reproductions, 200 Photo-Penni-Prints $20. 8 x 10 easily folded for mailing. Free estimates.

**PENNIPRINT CO.**

Dept. 13, P. O. Box 1159, Chicago 90



**ENGINEER**

Opportunity for a competent, Ingenious, Product Designer of Proven ability, to locate in Mild, Healthful Oregon with a nationally known, growing, Electronic Component and Electro-mechanical products manufacturer. Permanent. Enclose Resume in response.

**IRON FIREMAN MFG. CO.**

*ELECTRONICS DIVISION*

2838 S.E. 9th Ave. Portland, Oregon



No chance for gas or liquid leaks with . . NON-GRAN

*Spun* CENTRIFUGAL CASTINGS

help make products more dependable — more saleable. For details, write!

**AMERICAN NON-GRAN BRONZE CO.**

Berwyn, Penna.

Precision Machine Work

Castings — Sand and Centrifugal

10 to 12 ft. lengths ALL METALS

Also Screw Machine Products to Order

**EASTERN**

Machine Screw Corp. 12-32 Barclay St. New Haven, Conn. Makers of H & E Die Heads



**We Want to Acquire by Purchase or License**

**A NEW LINE OF MACHINE TOOLS**

Our client—a large, long established manufacturer of high precision machinery—wants a new and distinctive product line. We shall be interested in:

1. A small or medium size machine tool, such as a jig borer, surface grinder, contour grinder, broaching machine, gear generator, etc.
2. An accessory or attachment for machine tools.

The machine, accessory or attachment must be developed to the point of commercial use. Our client is prepared to supply working capital and production facilities needed for rapid development of the business.

Please write, referring to advertisement #64. No commission to us. We are compensated by our client.

**WELLING & WOODWARD, INC.**

*CONSULTANTS IN DIVERSIFICATION AND NEW PRODUCTS*

52 VANDERBILT AVENUE NEW YORK 17, N. Y.

## Quick ANSWERS to your business problems . . .

HUNDREDS of business problems can be quickly and easily solved through the use of the Searchlight Section of this or other McGraw-Hill publications.

The Searchlight Section is classified advertising; you can use it at small cost, to announce all kinds of business wants of interest to other men in the fields served by these publications. It is the accepted meeting place of men with business needs and the men who can fill those needs.

When you want additional employees or a position, want to buy or sell used or surplus equipment, want products to manufacture, seek new capital or have other business wants—advertise them in the Searchlight Section for quick, profitable results!

**The SEARCHLIGHT SECTIONS OF McGRAW-HILL PUBLICATIONS** Classified Advertising

American Machinist
Aviation Week
Business Week
Bus Transporation
Chemical Engineering
Chemical Week
Coal Age
Construction Methods & Equipment
Electrical Construction & Maintenance
Electrical Merchandising
Electrical Wholesaling
Electrical World
Electronics
Engineering and Mining Journal
E. & M. J. Metal & Mineral Markets
Engineering News-Record
Factory Management and Maintenance
Fleet Owner
Food Engineering
National Petroleum News
Nucleonics
Petroleum Processing
Power
Product Engineering
Textile World
Welding Engineering

*Classified Advertising Division*

**McGRAW-HILL PUBLISHING CO., Inc.**

*330 West 42nd Street*

*NEW YORK 36, N. Y.*


## PROFESSIONAL SERVICES


**ALLIED PRODUCTION SERVICE CO.**
*Electrical-Mechanical Engineering Consultants*
Machine, Tool, & Product Design & Development
Drafting Service — Technical Manuals
14 So. Park St., Montclair, N. J. — Established 1945 — Phone MO 2-9057, 9319

**GREEN AND SIMES**
*CONSULTING ENGINEERS*
Product Engineering Specialists
Hotel Mariemont Building — Cincinnati 27, Ohio

**GEORGE H. KENDALL**
*Consulting Mechanical Engineers*
Methods Studies: Process or Product
Redesign Existing Products for Greater Profit, Trouble Shooting Production, Design, Cost Problems, Specialist Automatic Machinery, Process, Controls, New Developments, Patent Studies, Investigations, New Products & Process Engineering Studies
P. O. Box 3 (*Est.* 1923) Tel. Darien 5-1504
Noroton Heights 3 Offices Darien, Connecticut

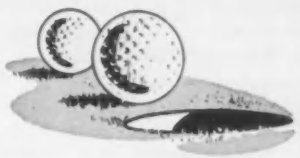
**NEW YORK TESTING LABORATORIES, INC.**
*CHEMICAL, MECHANICAL, ELECTRICAL METALLURGICAL ENGINEERS*
*ANALYTICAL CHEMISTS, PHYSICISTS, X-RAY*
Analysis, Tests of all Materials and Products, Plant and Field Services in Special Measurements of Stress, Sound, Vibration and other. Consultants in Litigation and Process Engineering and Design
80 Washington St. New York City 6, N. Y.

**R. C. OSBORN and ASSOCIATES**
*Electro-Mechanical Engineers*
• Product Development
• Styling
• Cost Reduction
Box 251 — Bloomington, Illinois

*The Consulting Engineer*

*By reason of special training, wide experience and tested ability, coupled with professional integrity, brings to his client detached engineering and economic advice that rises above local limitations and encompasses the availability of all modern developments in the fields where he practices as an expert.*

## engineers . . . physicists . . . STYMIED?



Have you come to a standstill in your work — future stymied?

Then by all means let us tell you about Melpar and the interesting assignments it can offer qualified men. We're increasing our engineering staff again . . . for the eighth consecutive year — and that means a real "ground-floor opportunity" for you.

We have a variety of challenging project assignments, both military and commercial including the following:

- Data Handling Equipment *(magnetic cores, magnetic recording equipment, digital computing techniques, analogue to digital conversion, shaft digitizers)*
- Flight Simulation *(servomechanisms, pulse, circuitry, electronic cabling)*
- High Frequency Antennas
- Audio and Video Circuit Design
- Small Mechanisms Design
- Mechanical Packaging of Electronic Components
- Measuring Techniques and fundamental investigations of the behavior of Mechanical Systems
- Radioactive Tracer Techniques
- Instrumentation and Control Devices *(servo, pneumatic and electric control)*

A grand future awaits you at Melpar — and pleasant living in the delightful suburbs of the Nation's Capital. Write us today for personal interview in your locality.

**Address Personnel Director**

**melpar** INCORPORATED

**440 Swann Avenue**
**Alexandria, Virginia**
**or Galen Street**
**Watertown, Mass.**

**A SUBSIDIARY OF THE WESTINGHOUSE AIR BRAKE CO.**

# INDEX OF PRODUCTS


## GENERAL ENGINEERING

Books ..... 355
Computers ..... 310
Drafting
  Supplies .....269, 336, 348, 359
Furniture, Engineering Dept..... 348
Photographic Equipment
  Film ..... 269
  Paper ..... 269
Reproduction Supplies.....269, 359
Testing Machines & Equipment..297, 358
Tracing Cloth .....330, 336
Tracing Paper ..... 359
Vibrators ..... 88
Vibratory Equipment ..... 88

## DEVELOPMENTS IN METALS & ALLOYS

Aluminum Alloys ..... 15
Bars .....38, 96
Brass ..... 91
Bronze .....15, 91
Carbide Alloys ..... 306
Clad Metals .....31, 219
Copper & Copper Alloys.....2, 91
Cupro-Nickel Alloys .....65, 91
High Temperature Alloys..... 86
Magnesium Alloys ..... 35
Metal Powder .....4th Cover
Phosphor Bronze ..... 91
Powdered Metal Parts....4th Cover, 4
Precious Metal Alloys..... 276
Rods .....15, 346
Rust Proofing ..... 8
Sheets .....122, Insert facing p. 256

Steel
  Alloy .....55, 66, 82, 217, 233, 244
  Carbon ..... 244
  Stainless ..60, 66, 82, 97, 122, 204, 221 233, 244, Insert facing p..256
  Tool .....92, 233, 244
Strips..60, 122, Insert facing p. 256, 346

Tubing
  Lock-Seam .....85, 223
  Seamless .....69, 80, 101, 221
  Welded .....69, 97, 223, 261, 333
Wear Materials .....84, 86, 219, 305
Wire .....61, 346
Wire Cloth .....73, 248, 300

## NON-METALLIC MATERIALS & FINISHES

Adhesives. Insert bet. 224 & 225 (Silicone)
Carbon ..... 344
Ceramics .....240, 305
Chemical Treatments .....8, 252, 255
Chemicals ..... 227
Coatings.....8, Insert bet. 224 & 225 (Silicone), 252, 255
Fibre .....48-49
Glass ..... 339
Insulation..Insert bet. 224 & 225 (Silicone)
Lacquer ..... 34
Plastic Parts ..... 6
Plastics..202, 227, Insert bet. 288 & 289 313
Plastics Fabricated.....106, 313
Plastics Laminated.....48-49, 106, 227 292-293, 313
Resins....22-23, 51, 202, Insert bet. 224 & 225 (Silicone), 227
Rubber ..... 45
Silicone Rubber....Insert bet. 224 & 225
Silicones .....Insert bet. 224 & 225
Tapes....Insert bet. 224 & 225 (Silicone)
Varnish..Insert bet. 224 & 225 (Silicone)

## FABRICATION & PRODUCTION PROCESSES

Assemblies ..... 254
Brazing .....24-25
Castings .....266, 320B
Castings, Precision Investment....86, 290
Cold Headed Parts.....272, 350
Cold Roll-Formed Shapes..... 223
Deep Drawing .....24-25
Die Castings ....42, 64, 78, 264, 280, 358
Dies ..... 113
Engineering Services (See also Production Services) .....273, 354
Extrusions .....315, 346
Fabricated Plastics ..... 349
Forgings .....86, 113, 263, 294, 319, 329
Honing Machines ..... 307
Inspection Equipment ..... 358
Knives & Blades..... 219
Laminated Plastics ..... 349
Machined Parts .....40-41, 113
Metal Forming .....24-25, 223

Moldings
  Plastics....6, 298, Insert facing p. 320 349
  Powdered Metal .....4th Cover, 279
  Rubber .....315, 346, 360
Production Machines & Processes... 84
Production Services...40-41, 86, 113, 273 324, 354
Punches & Dies..... 113
Rings & Loops..... 90
Rubber-Bonded-to-Metal....309, 346, 360
Rubber Coated Parts..... 334
Shapes, Roll Formed..... 47
Stampings .....86, 254, 285, 322, 330
Tools ..... 99
Weldments .....12, 90, 270, 324
Wire Forming .....254, 272

## POWER TRANSMISSION ELEMENTS

Actuators .....237, 317
Belts Insert bet. 32 & 33, 36, 60, 109, 328

Brakes
  Electric .....118-119, 326

Chains
  Roller .....11, 65, 79, 341
  Silent .....11, 65, 79

Clutches
  Mechanical .....65, 277, 340, 344

Couplings
  Mechanical .....65, 277, 344
Drives, Variable Speed..3rd Cover, Insert bet. 32 & 33, 60, 65, 81, 291
Flexible Couplings .....65, 79, 260, 277
Flexible Shafts ..... 334
Friction Materials ..... 77
Gear Motors .....3rd Cover
Gears.....46, Insert facing p. 256A, 275 276, 308, 312, 325, 330, 334
Motor Reducers (See also Gear Motors) 3rd Cover, 46, 275
Power Take-Offs ..... 340
Pulleys .....60, 328, 350
Ratchets ..... 308
Sheaves.....Insert bet. 32 & 33, 60, 328
Speed Reducers...3rd Cover, 46, 275, 287 325
Sprockets .....65, 79, 308, 341
Transmissions .....46, 63, 237, 291

## MECHANICAL PARTS & DESIGN

Balls .....336, 338

Bearings
  Ball.....33, 75, 112, 128, 213, 238, 257 332, 348, 351
  Jewel ..... 314
  Miniature .....128, 238
  Needle ..... 33
  Oil-less ..... 247
  Roller ..13, 14, 33, 76, 79, 83, 112, 238 257, 351
  Sleeve .....96, 247, 331, 343
Bellows ..... 95
Blowers ..... 342
Bushings .....96, 331
Conveyor Chains ..... 79
Conveyors .....79, 341
Counters ..... 17

# ADVERTISED IN THIS ISSUE


Gaskets .....20-21, 43, 332
Inspection Equipment ..... 297
Instruments .....33, 354
Jewels ..... 314
Lubricants .....236, 318
Lubricating Equipment...10, 71, 206, 251 303
Mountings ..... 309
Name Plates ..... 263
Packings ..... 103
Pillow Blocks .....79, 341
Seals .....2nd Cover, 18-19, 110, 259
Springs.....241, 338, 354
Thermostats .....295, 340
Vibration Dampers
Mechanical ..... 309
Vibration Mountings .....211, 258
Wheels ..... 328
Wire Cloth ..... 248


## FASTENING & JOINING TECHNIQUES


Adhesives ..... 54
Bolts .....70, 272, 312
Brazing Alloy ..... 249
Cam Fasteners ..... 32
Clamps ..... 126
Clips ..... 126
Fastening Methods .....37, 72, 126, 332
Flux .....100, 249
Locks .....332, 353
Nuts ..37, 44, 70, 126, 272, 312, 340, 358
Pins .....72, 312
Retaining Rings.....67, 126, 231, 342
Rivets .....37, 102, 272, 312
Screw Fasteners .....102, 286
Screws ..28-29, 58, 70, 107, 113, 272, 312 323, 338, 352, 358
Screw Thread Inserts..... 286
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.) 32, 37, 70, 102, 126, 267, 272, 323, 332
Washers .....231, 312
Welding
Equipment .....235, 368
Nuts ..... 316
Supplies ..... 368


## MOTORS, ENGINES & CONTROLS


Controls
Electrical.....62, Insert bet. 96 & 97
Drives, Adjustable Speed..Insert bet. 96 & 97, 118-119, 124
Engine Components (Pistons, Piston Rings, etc.) ..... 345
Engines .....225, 242, 335, 345, 357
Gear Motors....Insert bet. 96 & 97, 105 282, 352
Generators
A-C .....314, 357
D-C ..... 314
Magnetos .....16, 330
Motor Reducers .....81, 282
Motor Starters....62, Insert bet. 96 & 97
Motors, A-C
Fractional ....50, 52-53, 56-57, 81, 89 Insert bet. 96 & 97, 105, 114-115 118-121, 124, 281, 304, 352
Integral....89, Insert bet. 96 & 97, 105 118-121, 124, 281, 282, 352
Sub-Fractional .....50, 52-53, 56-57 Insert bet. 96 & 97, 105, 243, 314
Motors, D-C
Fractional .....50, 52-53, 56-57, 89 Insert bet. 96 & 97, 105, 114-115 118-121, 124, 352
Integral.....89, Insert bet. 96 & 97 105, 124, 282, 352
Sub-Fractional .....50, 52-53, 56-57 Insert bet. 96 & 97, 105, 314
Motors, High Frequency
Fractional ..... 50
Sub-Fractional ..... 50
Timing Motors ..... 301


## ELECTRICAL & ELECTRONICS COMPONENTS


Actuators .....265, 271
Assemblies ..... 268
Bi-Metal ..... 31
Coils .....296, 328
Computers ..... 310
Connectors .....215, 336
Contacts & Contact Materials.....31, 268
Controls
Electrical .....62, 340
Cords ..... 239
Dynamotors ..... 314
Electrical & Electronic Components, Custom Made ..... 350
Instruments .....333, 354
Insulating Varnish..Insert bet. 224 & 225 (Silicone)
Insulation.....Insert bet. 224 & 225 (Silicone), 313
Markers, Wire & Insulation..... 348
Plugs ..... 215
Regulators ..... 340
Relays .....253, 262, 265, 278, 288, 321
Solenoids .....322, 328, 354
Switches ..59, 62, 200, 260, 302, 310, 340 358
Tapes, Insulating...Insert bet. 224 & 225 (Silicone)
Thermostats .....30, 58, 340
Timers .....94, 118-119, 288, 310
Transformers .....328, 350
Wiring Devices ..... 62


## HYDRAULIC & PNEUMATIC EQUIPMENT


Accumulators .....74, 93, 289
Assemblies
Hydraulic ..... 74
Boosters ..... 93
Clamps ..... 284
Compressors ..... 245
Controls
Hydraulic ..... 74
Cylinders
Hydraulic .....74, 87, 93, 250, 283
Pneumatic .....93, 250, 283
Diaphragms ..... 259
Drives, Variable Speed.....74, 87
Filters
Air ..... 318
Hydraulic .....274, 318
Floats ..... 264
Flow Measurement ..... 229
Gaskets ..... 332
Instruments
Hydraulic ..... 333
Lubricants ..... 318
Motors
Air ..... 245
Hydraulic .....68, 74, 87, 111, 327
Packings ..... 103
Piping ..... 229
Power Packs .....68, 74
Pumps
Air .....245, 318
Liquid .....26-27, 68, 74, 87, 108, 111 256, 311, 318, 352
Vacuum .....245, 318
Regulators
Hydraulic ..... 74
Pneumatic ..... 10
Seals .....18-19, 110, 259
Shock Absorbers ..... 317
Strainers .....229, 264
Swivel Joints ..... 229
Valves
Air .....1, 10, 229, 246, 264, 342
Hydraulic .....71, 74, 87, 104, 229, 246 264, 342

# INDEX TO

*This index is published as a convenience to the readers. Every care is taken*


Abbott Ball Co. ... 338
Accurate Spring Mfg. Co. ... 241
Acme Welding Div., United Tool & Die Corp. ... 270
Aetna Ball & Roller Bearing Co. ... 112
Aircraft-Marine Products, Inc ... 99
Allegheny Ludlum Steel Corp. ... 92
Alemite ... 71
Allen Mfg. Co. ... 107
Allied Products Corp. ... 113
Allied Research Products, Inc. ... 255
Allis-Chalmers Mfg. Co. Insert Bet. 32 & 33
Allis Co., Louis ... 124
Allmetal Screw Products Co., Inc. ... 312
Alloy Metal Wire Div., H. K. Porter Co., Inc. ... 346
Aluminum Co. of America ... 38-39 Insert Bet. 64 & 65
American Blower Corp. ... 68
American Brass Co. ... 91
American Chemical Paint Co. ... 252
American Cystoscope Makers, Inc. ... 346
American Lava Corp. ... 305
American Welding & Mfg. Co. ... 90
Amplex Mfg. Co., Div. Chrysler Corp. ... 247
Armco Steel Corp. ... 204
Armstrong Cork Co., Industrial Div. 20-21, 43, 77
Arrow-Hart & Hegeman Electric Co. ... 62
Automatic Electric Mfg. Co. ... 288
Automatic Electric Sales Co. ... 200
Automatic Switch Co. ... 262
Automotive Rubber Co., Inc. ... 334

Bakelite Co. Union Carbide & Carbon Corp. Thermosetting ... 51
Bantam Bearings Div., Torrington Co. 33
Barksdale Valves ... 342
Barr Rubber Products Co. ... 346
Barry Corp. ... 258
Bearings Co. of America Div. of Federal Mogul Corp. ... 75
Belden Mfg. Co. ... 239
Bellofram Corp. ... 259
Benson Marine & Gear Co. ... 312
Berkeley Div. Beckman Instruments, Inc. ... 310
Bethlehem Steel Co. ... 12, 55
Bijur Lubricating Corp. ... 303
Bird Co., Inc., Richard H. ... 314
Blake & Johnson Co. ... 272
Bower Roller Bearing Co. ... 76
Brainard Steel Div. Sharon Steel Corp. 333
Breeze Corps., Inc. ... 237
Bridgeport Brass Co. ... 15
Brook Motor Corp. ... 281
Brown Engineering Co. ... 344
Bundy Tubing Co. ... 85
Bunting Brass & Bronze Co. ... 96

C. E. M. Co. ... 72
C & H Supply Co. ... 268
Cambridge Wire Cloth Co. ... 300
Camloc Fastener Corp. ... 267
Cannon Electric Co. ... 215
Cannon-Muskegon Corp. ... 244
Carboloy Department of General Electric Co. (Hard Metal) ... 306
Carpenter Steel Co., Alloy Tube Div. 97
Cash Valve Mfg. Corp., A. W. ... 246
Century Electric Co. ... 89
Chain Belt Co. ... 79
Chicago Rawhide Mfg. Co. ... 2nd Cover
Chrysler Corp., Industrial Engine Div. 225
Cincinnati Gear Co. ... 276
Clark Equipment Co. ... 63
Clearprint Paper Co. ... 330
Cleveland Cap Screw Co. ... 323
Cleveland Pneumatic Tool Co. ... 317
Clifford Mfg. Co. ... 95
Climax Molybdenum Co. ... 318
Cone-Drive Gears Div., Michigan Tool Co. ... 275
Control Products, Inc. ... 302
Corning Glass Works ... 339
Cramer Co., Inc., R. W ... 301
Crane Co. ... 229
Crucible Steel Co. of America ... 233
Cuyahoga Spring Co. ... 358

Daystrom Instrument Div. of Daystrom Inc. ... 354
DeLaval Steam Turbine Co. ... 325
Denison Engineering Co. ... 327
Detroit Coil Co. ... 322
Dormeyer Industries ... 328
Dow Chemical Co. ... 35
Dow Corning Corp. Insert Bet. 224 & 225
Drop Forging Association ... 329
Dudco Div., The New York Airbrake Co. ... 26-27
duPont de Nemours & Co., Inc., E. I. Neoprene ... 45
duPont de Nemours & Co., Inc., E. I. (Plastics) ... Insert Bet. 288 & 289
Durakool, Inc. ... 260

Eastman Kodak Co., Industrial Photographic Div. ... 269
Eastman Kodak Co., Special Products Sales Div. ... 297
Elco Tool & Screw Corp. ... 350
Electran Mfg. Co. ... 350
Electrical Engineering & Mfg. Corp. ... 271
Electro Engineering Products Co. ... 314
Electro-Snap Switch & Mfg. Co. ... 358
Electrol, Inc. ... 311

Fafnir Bearing Co. ... 213
Fairbanks, Morse & Co., Electric Motor Div. ... 52-53
Fairbanks, Morse & Co., Magneto Div. 330
Fairchild Engine & Airplane Corp. ... 356
Farval Corp. ... 251
Federal Die Casting Co. ... 264
Federal Mogul Corp. ... 331
Federal Tool & Mfg. Co. ... 322
Fenwal, Inc. ... 98
Firestone Plastics Co. Chemical Sales Div., Div. of Firestone Tire & Rubber Co. ... 23
Foote Bros. Gear & Machine Corp. ... 46
Ford Instrument Co. ... 337
French & Hecht Div. Kelsey Hayes Wheel Co. ... 328
Frenchtown Porcelain Co. ... 240
Fulton Sylphon Div., Robertshaw-Fulton Controls Co. ... 295
Funk Aircraft Co. ... 340

Gast Mfg. Corp. ... 245
Gates Rubber Co. ... 109
General Electric Co. Apparatus Dept. 118-121
General Industries Co. ... 243
General Tire & Rubber Co., Industrial Products Div. ... 211
Gerotor May Corp. ... 111
Gibson Electric Co. ... 268
Glidden Co., The ... 34
Globe Steel Tubes Co. ... 101
Goodrich Co., B. F. (RIVNUT) ... 37
Goodyear Tire & Rubber Co. (Mech. Gds.) ... 315
Gray Iron Founders' Society, Inc. ... 320B
Great Lakes Steel Div., National Steel Corp. ... 217
Greer Hydraulics, Inc. ... 289
Gries Reproducer Corp. ... 358
Guardian Electric Mfg. Co. ... 321

Hamilton Watch Co., Allied Products Div. ... 40-41
Handy & Harman ... 249
Hartford Steel Ball Co. ... 336
Hartwell Co. ... 332
Haynes Stellite Co., Div. of Union Carbide & Carbon Corp. ... 86
Heinze Electric Co. ... 342
Heli-Coil Corp. ... 286
Hilliard Corp. ... 277
Hitchiner Mfg. Co., Inc. ... 290
Howard Industries, Inc. ... 50
Hunter Douglas Corp. ... 319
Hyatt Bearings Div., General Motors Corp. ... 14
Hydreco Div., The New York Airbrake Co. ... 26-27

Imperial Pencil Tracing Cloth ... 336
Indiana Gear Works Inc. Insert facing 256A
Industrial Timer Corp. ... 94
International Nickel Co., Inc. ... 66

Jeffrey Mfg. Co. ... 341
Johns-Manville Corp. (Packings) ... 110
Johnson Bronze Co. ... 343

Kaydon Engineering Corp. ... 257
Keuffel & Esser Co. ... 359
Kilian Mfg. Corp. ... 348
Koppers Co., Inc., Chemical Div. ... 227
Kraissl Co. ... 318
Kuhn and Jacob Molding & Tool Co. ... 298
Kurz-Kasch, Inc. ... 6

Landis & Gyr Inc. ... 238
Leland Electric Co., Div. The American Machine & Foundry Co. ... 56-57
Leland Inc., G. H. ... 354

# ADVERTISERS

*to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.*


Linde Air Products Co., Div. of Union Carbide & Carbon Corp.....84, 368
Linear, Inc.....103
Link-Belt Co.....11, 13
Lord Mfg. Co.....309
Lovejoy Flexible Coupling Co.....350
Lubriplate Div. Fiske Bros. Refining Co.....236
Lycoming Div. Avco Mfg. Corp.....345

McGraw-Hill Book Co., Inc.....356
McLouth Steel Corp....Insert facing 256
M B Mfg. Co., Inc.....88
Mallory & Co. Inc., P. R.....4, 59
Marvel Engineering Co.....274
Master Electric Co. (Speedmaster) 3rd Cover
Mathieson Chemical Corp.....100
Maurey Mfg. Corp.....328
Mayline Co.....348
Metals & Controls Corp., General Plate Div.....31
Metals & Controls Corp., Spencer Thermostat Div.....30
Michigan Tool Co., Cone Drive Gears Div.....275
Micromatic Hone Corp.....307
Midland Steel Products Co.....316
Miller Fluid Power Co.....93
Mills Plastic Div. Continental Can Co. Insert facing 319
Minnesota Mining & Mfg. Co.....54
Monsanto Chemical Co., Plastics Div. 202
Morganite, Inc.....344
Morse Chain Co.....65
Mt. Vernon Die Casting Corp.....64
Mueller Brass Co.....263

National Band & Tag Co.....348
National Lock Washer Co. (Retaining Rings).....231
National Malleable & Steel Castings Co.....265
National Motor Bearing Co., Inc....18-19
National Screw & Mfg. Co.....70
National-Standard Co.....61
National Steel Corp.....217
National Tube Div. U. S. Steel Corp. 80
Neise, Karl A.....354
Newark Wire Cloth Co.....248
New Departure Div., General Motors Corp.....128
New York Airbrake Co., The.....26-27
Ney Co., J. M.....276
Nicholson & Co., W. H.....264
Nordberg Manufacturing Co.....242
Norgren Co., C. A.....10, 206
North Mississippi Industrial Development Association.....348

Ohio Knife Co.....219
Oilgear Co.....87
Onan & Sons Inc., D. W.....357
Ortman-Miller Machine Co.....283

Parker-Kalon Div., General American Transportation Corp.....28-29
Parker Rust Proof Co.....8
Parker White-Metal Co.....78
Perkins Machine & Gear Co.....308
Pesco Products Div., Borg Warner Corp.....108
Phillips Control Corp.....265
Power Products Corp.....335
Product Engineering.....116-117

RBM Div. Essex Wire Corp.....278
Ramsey Corporation.....342
Reeves Pulley Co.....291
Republic Steel Corp., Alloy Steel Div. 82
Republic Steel Corp. (Steel & Tubes) 221
Resinite Corp.....296
Reuland Electric Co.....282
Revere Copper & Brass Inc.....2
Reynolds Metal Co.....24-25
Reynolds Wire Div., National Standard Co.....73
Rhodes Inc., M. H.....310
Rhode Island Tool Co.....294
Richardson Co.....349
Rivett Lathe & Grinder Inc.....104
Robbins & Myers Inc.....114, 115
Rockford Clutch Div. Borg-Warner Corp.....344
Rogers Corp.....313
Roll Formed Products Co.....47
Ross Operating Valve Co.....1
Roth Rubber Company.....360
Ruthman Machinery Co.....352

SKF Industries, Inc.....351
Sandsteel Spring Div., Sandvik Steel Inc.....338
Sciaky Brothers Inc.....235
Scintilla Div., Bendix Aviation Corp. H & K Magnetos Div.....16
Scintilla Div., Bendix Aviation Corp. Electrical Conn.....336
Scruggs Co., Loyd.....304
Set Screw & Mfg. Co.....352
Sewall Mfg. Co., E. B.....334
Simmons Fastener Corp.....32
South Chester Corp., Southco Div....102
Spaulding Fibre Co., Inc.....106
Split Ball Bearing Co.....332
Standard Pressed Steel Co.....44, 58
Standard Tube Co.....261
Stearns Magnetic, Inc.....326
Sterling Electric Motors Inc.....81
Sterling Engineering Co., Inc., Div. American Machine & Foundry Co..253
Stewart Warner Corp. (Alemite).....71
Stewart Warner Corp. (Die Casting Div.).....42
Stow Mfg. Co.....334
Strong Carlisle & Hammond Co.....338
Synthane Corp.....292-293

Taylor Fibre Co.....48-49
Taylor-Winfield Corp.....324
Thomas Flexible Coupling Co.....260
Timken Roller Bearing Co. (Industrial).....83
Tinnerman Products Inc.....126
Titchener & Co., E. H.....254
Tomkins-Johnson Co.....250
Torrington Co., Bantam Bearing Div. 33
Townsend Co.....299
Transue & Williams Co. Stamping Div.....285
Tuthill Pump Co.....256
Twin City Die Casting.....280

Union Carbide & Carbon Corp. Bakelite Company.....51
Haynes Stellite Company.....86
Linde Air Products Co.....84, 368
United Electric Controls Co.....340
United Manufacturing Co.....360
U. S. Electrical Motors Inc.....352
U. S. Graphite Co.....4th Cover
U. S. Rubber Co.....36
U. S. Steel Export Co.....80

Van Huffel Tube Corp.....223
Veeder-Root Inc.....17
Vellumoid Co.....332
Vickers, Inc.....74

Waldes-Kohinoor, Inc.....67
Washington Steel Co.....122
Western Gear Works.....273
Westfield Metal Products Co., Inc .340
Westinghouse Electric Corp. Insert Bet. 96 & 97, 105
Winsmith Inc.....287
Winzeler Mfg. & Tool Co.....330
Wittek Manufacturing Co.....284
Wolverine Tube Div. Calumet & Hecla, Inc.....69
Worthington Corp. Multi-V Drive...60

Yale & Towne Mfg. Corp. Powered Metal Products Div.....279
Yale & Towne Manufacturing Co. Stamford Div.....353


■


PROFESSIONAL SERVICES .....363


SEARCHLIGHT SECTION
*(Classified Advertising)*
H. E. Hilty, Mgr.


EMPLOYMENT
Positions Vacant .....362, 363
Positions Wanted .....362
Selling Opportunities Wanted .....362
SPECIAL SERVICES
Contract Work .....362
BUSINESS OPPORTUNITIES
Offered .....362

# Are Weld Rejections Cutting Your Profits?

**Here's How You Can Reduce Rejection Rates in Your Inert Gas Shielded Arc Welding Operations**

Every time a welded assembly is rejected because of weld contamination, an unnecessary bite is taken out of your profits. You can reduce these rejection losses to a minimum by specifying 99.99% pure LINDE argon. High purity argon is your insurance that your welds will be free from contamination and porosity—resulting in fewer rejects and higher profits.

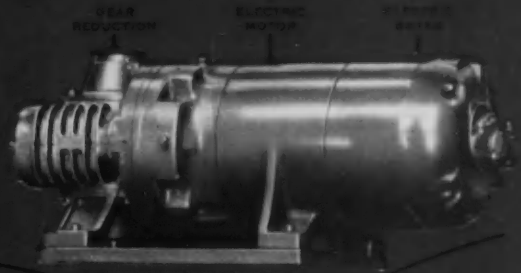
But there's more to the LINDE story. You can be sure of your gas supply when you order LINDE argon. LINDE's many strategically located plants and distribution facilities can be counted upon to provide all the high purity argon you need even when unexpected production peaks exceed normal demands. In addition, you can call upon LINDE's Engineering Service to help you solve tough production problems when time means money.

Call your nearest LINDE office today for more information about how LINDE argon — plus LINDE Engineering Service can mean increased production and greater profits for you.

**Linde Air Products Company**
**A Division of Union Carbide and Carbon Corporation**
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: DOMINION OXYGEN COMPANY
Division of Union Carbide Canada Limited, Toronto

Linde Trade-Mark

The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.

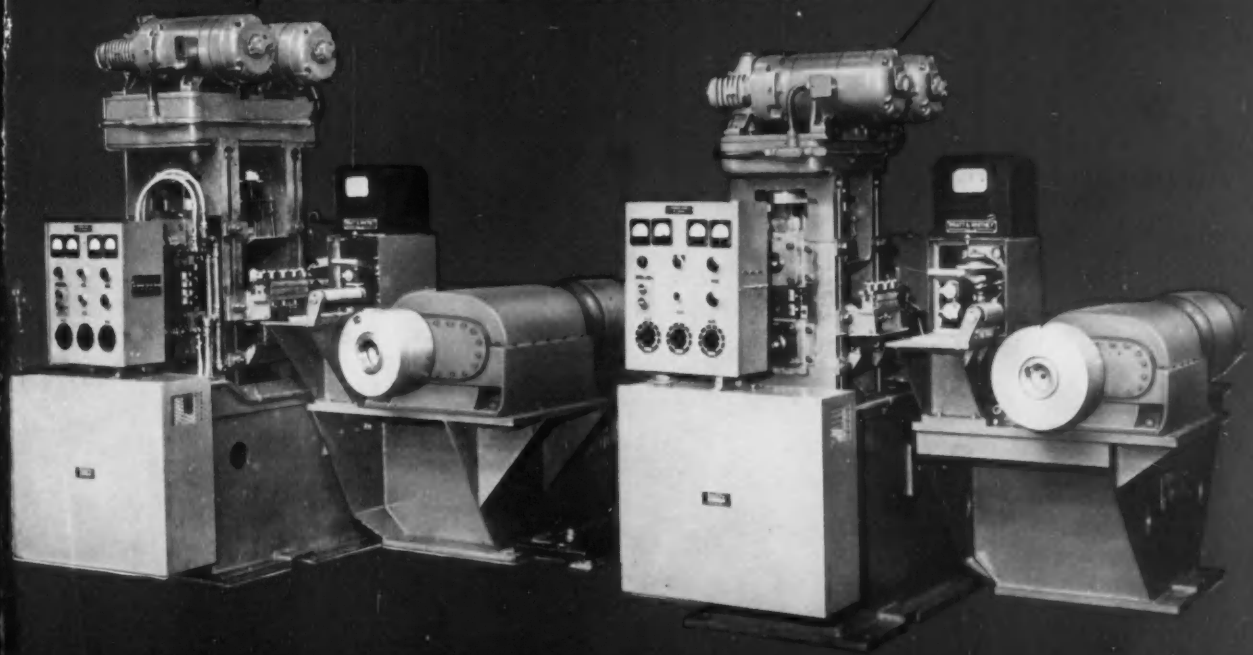


See how easily the standard electric motor, standard gear reduction, standard electric brake combine into a drive that gives the RIGHT horsepower, the RIGHT shaft speed, the RIGHT features . . . all in one compact unit. Nowhere else will you find power units that are so flexible, so easily adaptable, and in such a wide range of types and ratings.

Master power drives are available in thousands and thousands of ratings (⅛ to 400 HP) . . . in open, enclosed, splash proof, fan cooled, explosion proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed and variable speed types . . . with or without flanges or other special features . . . with 5 types of gear reduction up to 430 to 1 ratio . . . with electric brakes . . . with fluid-drive . . . with mechanical or electronic variable speed units . . . and for every type of mounting . . . Master has them all and so can be completely impartial in helping you select the one best power drive for you.

## standard units easily combine into special purpose drives

**THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO**



# GRAMIX® sintered metal parts

- save metal, machining time and money
- cost less in production quantities
- can be oil impregnated for self-lubrication
- improve product performance

iron brake wheel 60¢
bronze split clamp 11¢ a pair
bronze friction clamp 4¢
iron spring retainer 33¢
iron bearing 1½¢
iron die casting insert 4¢
bronze check valve seat 13¢
nickel silver insert 3¢
shouldered iron bearing bracket 29¢

103

OUR 100th YEAR

## THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN